THE AMERICAN BREEDERS MAGAZINE

"One of the most precious things in the world is the labor of human beings; and I find myself asking over and over: 'What a vast difference in the reward of labor does it make what kind of seeds are planted on the millions of cultivated acres?' I have not yet answered my own question, but ask you to remember that the problem raised is also yours."—A. M. FERGUSON.

Vol. III **Second Quarter, 1912** **No. 2**

A. E. BLOUNT, 1831-1911

W. H. OLIN

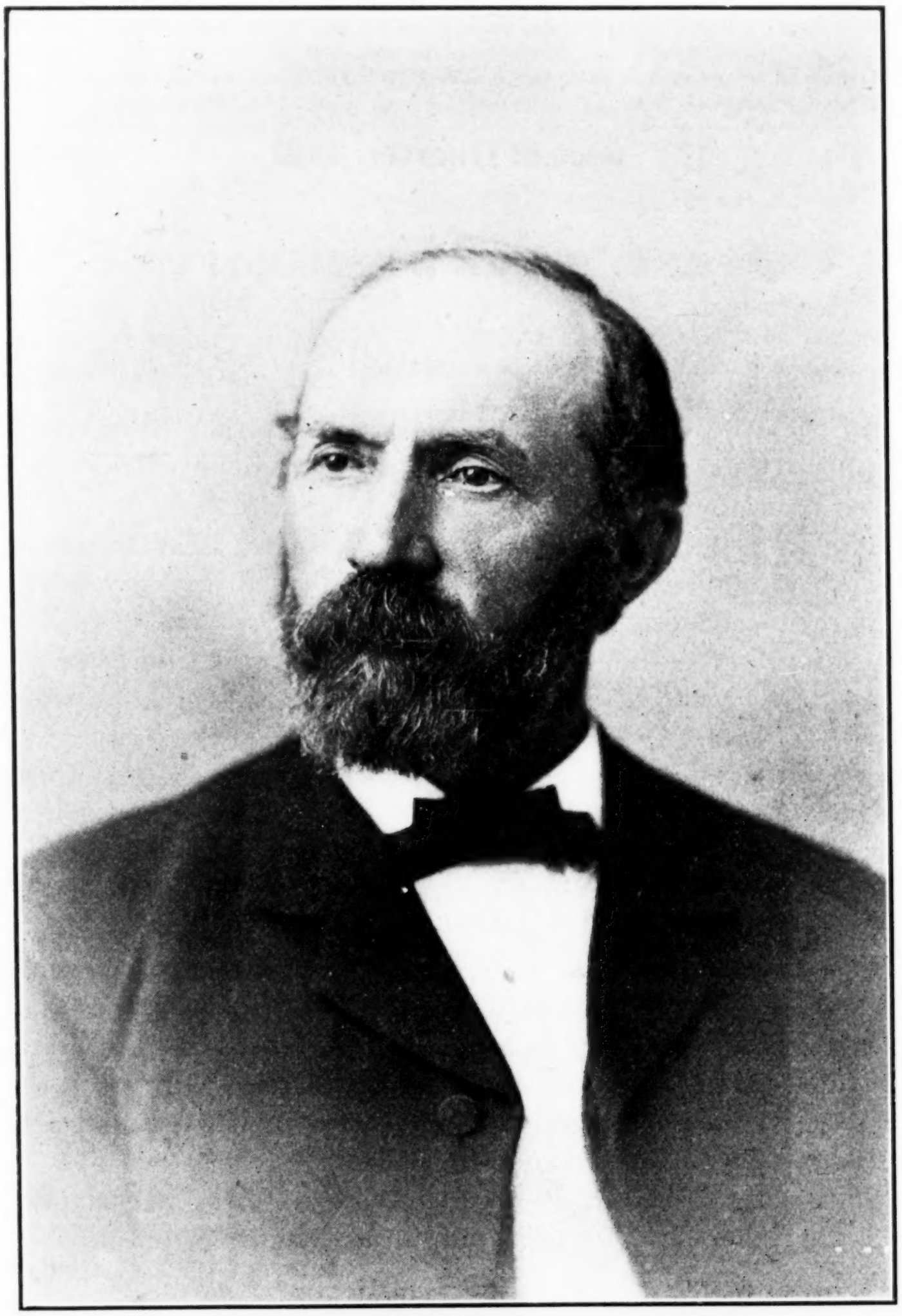
Boise, Idaho

Since the 1911 meeting of the American Breeders Association at Columbus, Ohio, one of the pioneer plant breeders of America has "passed over the range"—Prof. A. E. Blount.

Ainsworth Emery Blount was born at Brainard, East Tennessee—a mission station—February 6, 1831. He passed his early boyhood in that region, leading a simple form of life in the midst of the Cherokee Indians. His children later in life delighted to hear their father talk and sing in the Cherokee language, which he learned from his boyhood playmates.

On his father's side Professor Blount was descended from Puritan stock, while his mother, born Harriet Ellsworth, was granddaughter of Oliver Ellsworth, first Chief Justice of the United States, and member of that memorable convention which drafted the Federal Constitution in 1787. Professor Blount graduated from Dartmouth College in 1859, and at the time of the Civil War he was principal of the Masonic Female Institute, Cleveland, Tenn. He resigned his position at the opening of the war; entering the first East Tennessee Cavalry as a private, he came out of the war with the rank of captain in above named regiment. In 1865 he married the daughter of Dr. J. F. Hall of Portsmouth, N. H.

After the Civil War, Professor Blount began elaborate investigations in the principles of heredity and the breeding of cereals. He was the first plant breeder in the cereals—corn and wheat—as well as one of the first workers with and propagators of alfalfa in America. The writer believes Professor Blount to have been the first plant breeder in America to use as the fundamental principle which governed all his breeding work with the cereals: "Select the *best* to *cross on the best* to make a *better offspring*." It is the use of this rule which has en-



A. E. Blount

abled Luther Burbank and others to produce such desirable and valuable results in nuts, fruits, flowers, and grains.

In his corn work Professor Blount began with an eight-rowed white dent corn and, after ten years' work in crossing and selection, he had created a new variety, Blount's Prolific. Of this, he says: "I had the satisfaction of putting into the hands of real live farmers a variety that excelled anything in the shape of maize that, up to that time, had been grown in America, as the *Rural New Yorker* of 1879 fully illustrates. It is still for sale all over the country by no less than a dozen seed houses, but, sad to say, it is so deteriorated that its prolific feature is hardly left. Corn mixes so readily it is impossible, even isolated miles away from all other kinds, to keep pure and genuine seed without a yearly protection."

Professor Blount was the first one to introduce durum wheats in the United States. It was while Professor Blount was at the Colorado State Agricultural College as Agriculturist that probably his greatest work was done in seed breeding.

Speaking of this work in correspondence with the writer he says: "While there [in Colorado], in 12 of the best years of my life, I made many crosses between the best varieties, only 43 of which were worth propagating. I then called them hybrids, but on further investigation declared them only '*crosses*,' *not* hybrids. It was in 1879 that I received a very small sample of the then smooth Defiance Wheat and his Champion Bearded No. 9 from E. C. Pringle (Vt.), who claimed to have 'originated' them—how he never told me, though I sought to know his method. From this seed I gained quite a large number of average heads, the largest, if I remember rightly, not quite 3 inches long, with only about 21 kernels in the glumes, including the white cap. The next year I selected the 'best and crossed the best on the best to get a better offspring'—the rule I worked on in all my experiments. In 1885 you will see how much it was improved by 'selecting the best to cross on the best to get a better offspring.' See No. 8, page 44, Secretary's Report for 1886.

Professor Blount told the writer in a letter that one single grain of Defiance in his nursery, under irrigation, produced 106 good heads containing an average of 43 kernels each, heads fully 5 to 6 inches long from base to tip of white-cap.

The president of the college was a man of classical training who did not appreciate the work being done by Professor Blount, and the director of the experiment station—a graduate of the Agricultural College of Michigan—refused to recognize the worth and value of this vet-

eran plant breeder's most excellent work and so the world at large learned little of what was being done. It is to be regretted that much of the best work in plant breeding done by Professor Blount at the Colorado Station was lost after he was driven from the station by college politics. He had in his nursery over 400 named varieties of wheat, most of which he knew at a glance without consulting the labels. He was in correspondence with 40 of the best plant breeders of his day, in Australia, Asia, England, Continental Europe, North and South America. From 1890 to 1898 Professor Blount did active and valuable work in the new agricultural station of New Mexico. Failing health caused him to retire from active service. He spent his last years in his truly delightful home among family and friends at Wellesley, Mass. Even here, he was consulted by plant specialists for advice, for his experience, perseverance, and capacity for accurate and delicate work had made him an authority on plant breeding. As long as he lived he was constantly in receipt of letters from all the wheat-growing states and foreign countries growing this cereal.

His death, February 21, 1911, was caused by an attack of pneumonia. Defiance Wheat is his gift to the Irrigated West, demonstrated by miller and farmer to be the best milling spring wheat grown on the irrigated lands of America. He was a most modest man, an untiring investigator, a great lover of nature and of little children, as well as of plants and flowers. He attained success. A speed-mad and money-mad commercialized world would perhaps not consider it such. The writer inclines to proclaim as a successful man, one who has added one flower, one food grain, fruit or economic plant, useful to man or beast; who has not lost the love of little children; who has learned the love of Nature, and though he may not have amassed wealth, has made the world better for his having lived in it, living a life that speaks for purity, truth and love. Such success Blount had achieved.

THE CORNELL EXPERIMENTS IN BREEDING TIMOTHY[a]

HERBERT J. WEBBER

Ithaca, New York

Introduction.—Almost all of our cultivated plants and animals are represented by numerous varieties and breeds. We do not cultivate merely wheat, corn, or apples, but we grow Dawson's Golden Chaff wheat, Leaming corn, or Baldwin apples. We have hundreds of races of corn and wheat and over a thousand varieties of apples. In cotton, oats, barley, peaches, plums, pears, strawberries, and, indeed, in almost all plants that man has domesticated, we find numerous varieties. Not so, however, in timothy, our greatest of all hay plants. Timothy is only timothy. When we buy timothy seed we do not ask for Excelsior timothy or Jones' timothy; we simply order timothy seed, and take seed from Illinois, Michigan, Iowa, or any other place if it is called timothy. Sometimes we ask for a guarantee that the seed is good, but by this we mean only that it will germinate. We do not concern ourselves with the all-important question of how much hay per acre it will produce. When we remember that the hay crop ranks among the three largest crops in value produced in the United States, and that timothy forms the bulk of this crop, it is difficult to conceive that this can be true, but such is the deplorable fact.

So far as the writer is informed only one series of experiments in the breeding of timothy has been carried to a successful conclusion. Between 1895 and 1899, Dr. A. D. Hopkins, then of the West Virginia Experiment Station, made selections of good timothy plants observed in nature and found that they could be bred into distinct varieties.[b] These varieties were later placed with the U. S. Department of Agriculture for trial, but have not been introduced into general cultivation.

It is clear that the most important problem before hay growers today is to secure improved varieties which are known to be adapted to certain local conditions and fitted to give the best hay under these conditions. Not until good varieties adapted to various regions have been secured can we expect any very general improvement and increase in the hay crop of the country.

The Cornell Experiments.—The Cornell experiments in breeding timothy were started in 1903 under the direction of Prof. T. F. Hunt,

[a] Paper No. 25, Department of Plant-Breeding, Cornell University, Ithaca, New York.
[b] Hopkins, A. D., Proc. Soc. Pro. Agr. Science, 1895, pp. 29-33.

assisted by Professor Gilmore and Mr. Fraser. The writer was placed in charge of the experiments in the spring of 1907, and from that time until 1910 he was assisted in the work by Dr. C. F. Clark.

In order to secure various forms, seed was obtained from 231 different places throughout the world, 21 states, Canada, Japan, and 9 European countries being represented. These seeds were germinated in sterilized soil and the little plants grown for a time in the greenhouse. They were later transplanted into field plats, 42 plants being grown from each lot of seed. In the field the plants were placed in rows 30 inches apart each way in order to facilitate the cultivation and allow the full development of each individual. Grown under such conditions the plants gradually increase in size by stooling and the most vigorous individuals in two or three years reach a diameter of from 1 to $1\frac{1}{2}$ feet. Little can be told regarding their characters until the second year, when they begin to show clearly their mature character. No final conclusions can be drawn regarding the comparative value of the individuals until they have been under observation for four or five years.

In 1905 certain distinct plants were selected from among this lot, and open-fertilized seed retained, which was used in planting individual test rows, the plants being handled and planted separately as in the preceding case.

The original planting of 1903 included about 20,000 different individual plants, while that of 1905 included 6304 plants. A good stand was obtained at first, but a considerable number of plants died later from various causes. When the writer took charge of the experiments in 1907 there were probably about 20,000 different plants still living, and in most cases they were in excellent condition. At that time all of the plants had reached sufficient age to permit their mature characters to show plainly and thus were in prime condition for studying the variations and for choosing plants of different types.

Variations in Timothy.—The variations in different plants of timothy cannot be observed plainly when the plants are grown under field conditions. It is necessary to have the individual plants grown alone with considerable space around them in order to study the variations. No one who has not studied such a field of timothy plants can comprehend the richness of forms presented. It is beyond the scope of such a paper as this to discuss all of the forms presented, but the following illustrations will give some idea of the variation in those characters that are of most importance from a practical standpoint.

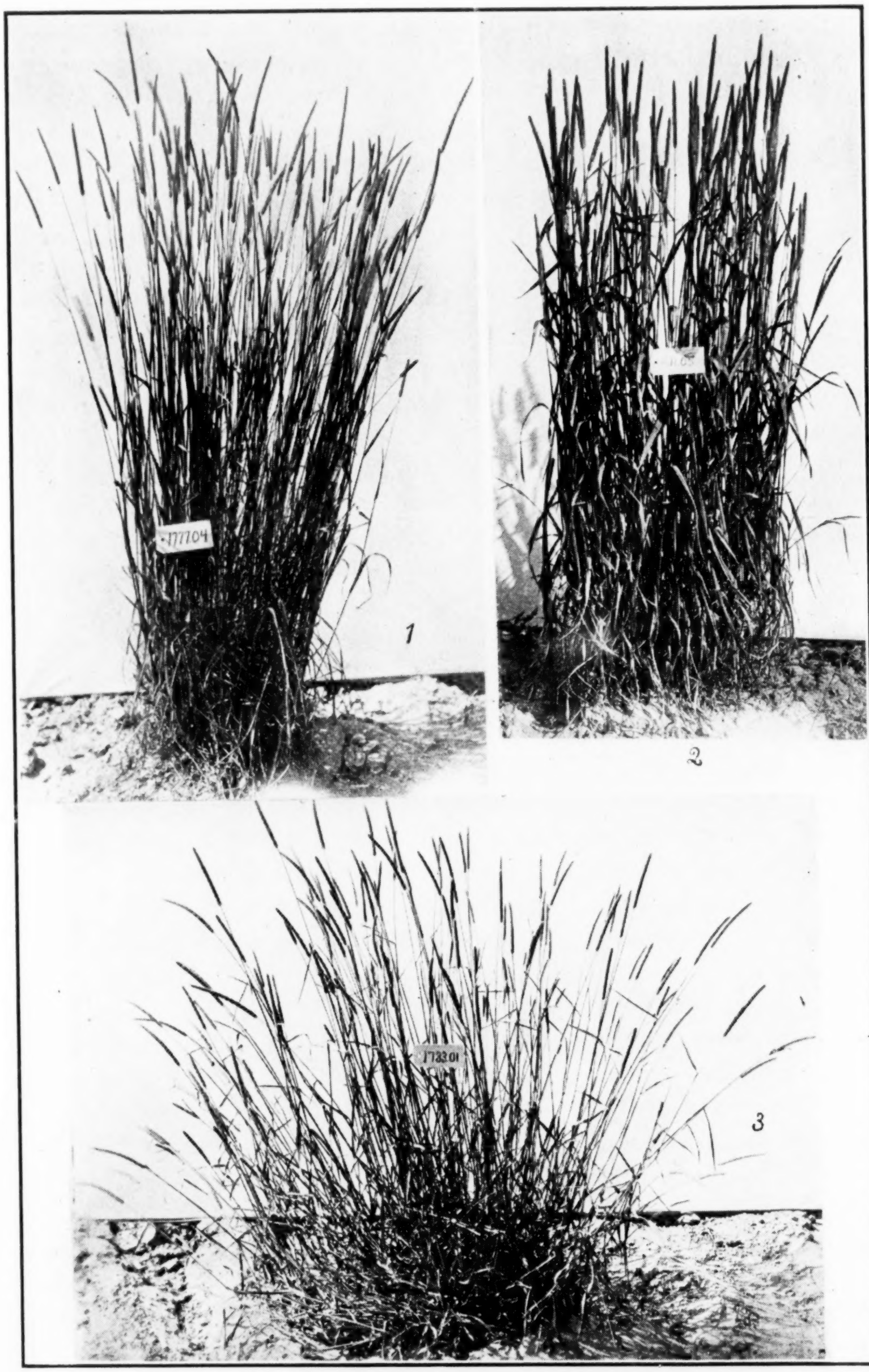


PLATE I.—VARIATIONS IN TIMOTHY.

1, A tall fine hay type; 2, a large tall, erect, dense, broad-leaved type; 3, a medium low spreading type.

Yield depends primarily upon the height and diameter of the plant and upon the density or number of culms developed and also on the size of each culm, size of head, number and size of leaves, and the like.

In height, the plants ranged from 18 inches to 55 inches, as shown by Dr. Clark's summary. Some are veritable dwarfs and others giants. The diameter of the plant is independent of height. Some of the dwarf plants formed in a given period clumps almost as large in diameter as the tall plants. Many plants of three and four years of age will remain very small, showing very little stooling and producing each year only a half dozen or a dozen culms. Other plants stool abundantly and form clumps from 1 foot to $1\frac{1}{2}$ feet or more in diameter, with hundreds of culms.

In the original planting of 1903 the range of variation in yield of dried hay per plant was from 0.16 of an ounce to 21.60 ounces. If this difference in the yield of individual plants is transmitted, fields sowed with small and large yielders should show considerable difference in this important character.

The stems vary greatly in their diameters and ability to stand erect, some individuals showing a decided tendency to lodge.

The leaves vary greatly in length and width but show little variation in number. The great majority of plants produce almost regularly 5 nodes with 5 leaves, but occasionally plants are found which develop normally from 6 to 7 nodes and as many leaves, while occasionally also a lower number of nodes, 3 to 4, is found as the normal number. This character, however, apparently means but little in the production of valuable sorts.

The heads also present a large range of variation in size and shape. They are long and short, thick and thin, smooth and simple, or rough and branched, and the like.

Plants differ also in density, position of leaves, color, time of ripening, resistance to disease, and hosts of other characters more or less important. In season of maturity a variation of from two to three weeks is occasionally found, which is a very important character. The variation in susceptibility to rust (*Puccinia graminis*) is one of the most valuable characters observed. Some plants are badly affected every year, while other plants remain almost wholly free from this most serious disease of timothy.

The question of importance is whether these various individuals showing valuable characters will reproduce these characters, or whether they are hybrids or accidental variations that are unstable

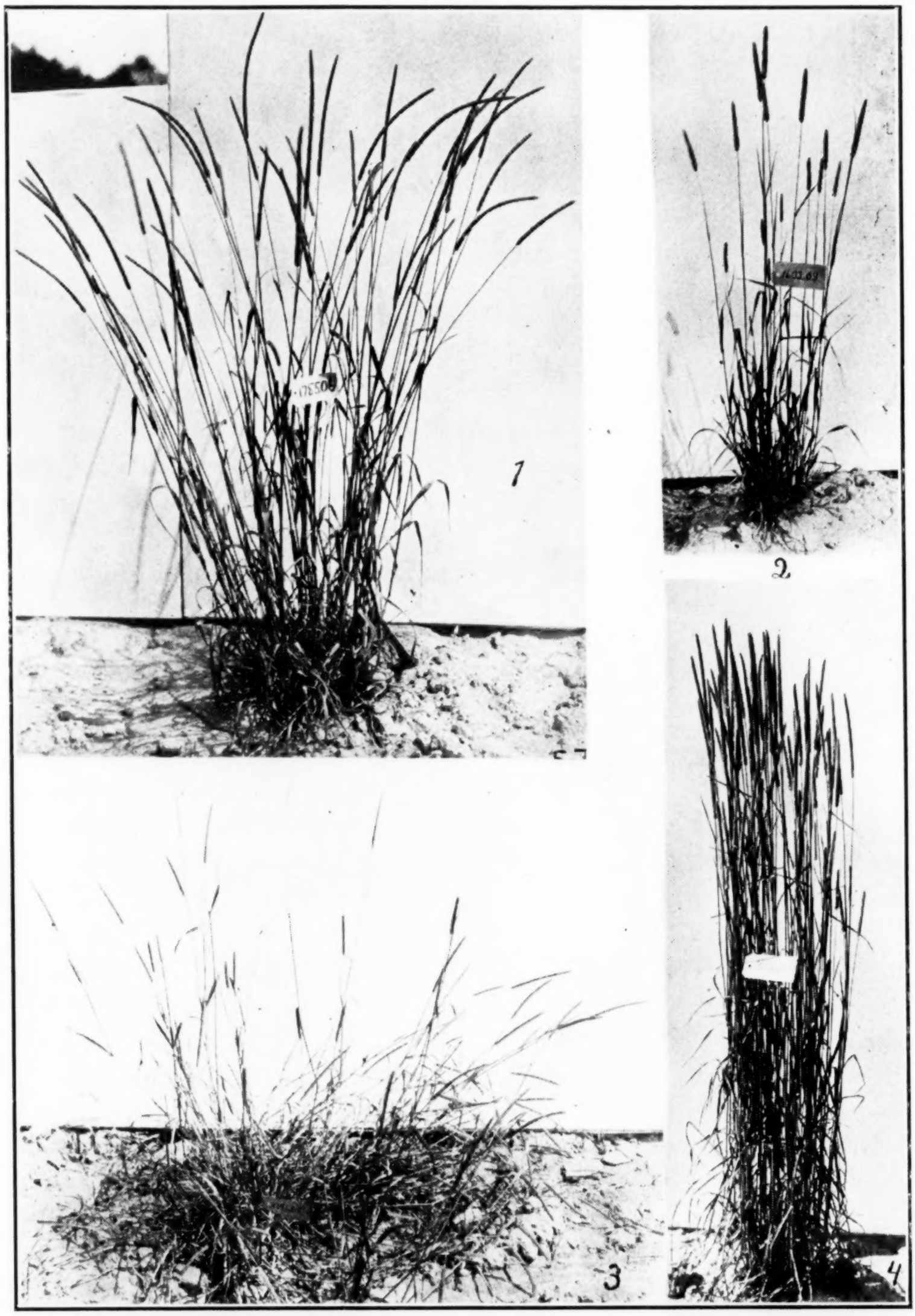


PLATE II.—VARIATIONS IN TIMOTHY.

1, A tall open type with few culms and long heads; 2, a low yielding dwarf type; 3, a lodging type with weak stems normally bending over; 4, a very tall erect plant but small in diameter.

in nature. The selection and testing of such variations has formed the basis of the experimental work since 1907.

Methods of Experimentation.—Plats grown from open-fertilized seed were found to show great variation and little indication of a transmission of the characters for which the plants were selected. Timothy is normally a cross-fertilized plant, and when plants are grown in a mixed field where they are freely crossed with all sorts of pollen, this lack of transmission would be expected. A few heads protected from cross-pollination by covering with paper bags in 1907 gave a few good seeds, showing that at least some seed would set by self-fertilization. Since that time each season a considerable number of the selected plants have been protected from cross-pollination by covering the entire plant with small cloth tents, or by covering certain heads with paper bags. In this way self-fertilized or inbred seed has been obtained from a large number of select types for testing.

The test of any particular chosen plant is conducted in the following way.

(1) The selected plant is propagated vegetatively by digging up and separating the bulbs that are formed in the stooling of the plant. These are taken in early September and a row of from 16 to 24 plants grown. These plants, it will be understood, are simply transplanted parts of the same individual. From such propagation the character of the individual can be judged much better and a more reliable idea can be obtained of the yielding capacity of the plant as well as other characters.

(2) Inbred seed is carefully grown in sterilized soil and the seedlings transplanted in rows in field plats as above described, to test the transmission of the characters for which the plants were selected.

(3) As soon as sufficient seed can be obtained, plats of the different select types are sowed broadcast in the usual way to test the yield under ordinary field conditions.

(4) As soon as a variety is known or believed to be valuable, isolated plats are planted with inbred seed to obtain seed for planting large areas which will finally give sufficient quantities of seed for distribution.

A large number of types have now been tested more or less thoroughly by these methods and very suggestive results obtained.

Do the Variations Transmit their Qualities?—In 1907 over 200 different types were propagated in rows by taking the bulbs and

PLATE III.—VARIATIONS IN TIMOTHY.

1, A low dwarf type; 2, a low yielding type with few culms; 3, a heavy yielding good type, tall, large in diameter and dense; 4, a light yielding plant with few and spreading culms.

growing them as clonal[c] varieties. The examination of these rows when they were two, three, and four years old showed wonderful differences in type and clearly demonstrated that the differences first observed in the individual seedlings were by no means accidental. Dwarf plants remained dwarf in such rows and giants remained giants. Heavy yielders and light yielders transmitted these qualities in wonderful degree (see Plate IV). In the following table the records of the average yield per plant by clonal propagation in 5 light-yielding and 5 heavy-yielding rows will give an indication of the differences

TABLE 1.—*Showing transmission of yield in timothy by clonal and seed propagation.*

No. of Original Plant.	Plat No.	Average yield per plant of mother by clonal propagation. *ounces.*	Plat No.	Average yield per plant of progeny by seed propagation. *ounces.*
		LIGHT-YIELDING PLANTS.		
9.02	1786	2.672	3104	1.666
12.07	1797	.768	3216	1.875
17.25	1728	1.744	3167	1.411
128.19	1799	2.672	3217	0.857
211.31	1792	2.464	3211	1.333
		HEAVY-YIELDING PLANTS.		
9.03	1611	15.520	1916	10.533
37.31	1630	19.680	1909	9.714
147.41	1620	15.008	1906	10.000
269.41	1743	16.592	1931	9.428
278.40	1752	15.904	1942	9.500

between the various types in this one important character. (See Table I, column headed "Average yield per plant of mother by clonal propagation.")

In 1908 and 1909 test rows of plants from inbred seed of a considerable number of different types were planted, and in many cases by the side of these were grown rows from open-fertilized seed and from clons of the same original plant. These plats had reached sufficient size in 1910 and 1911 to allow careful study and judgment. The writer is now able to state definitely that a very large number of the variations selected have transmitted their characters in marked

[c] A clon or clonal variety is one propagated vegetatively by cuttings, bulbs, or grafts, such as the varieties of strawberries, apples, and the like.

PLATE IV.—HEAVY AND LIGHT YIELDING PLANTS.

Propagated in rows as clonal varieties and showing the transmission of these characters.

degree. Indeed, many of the types appear to be as uniform as any of the varieties of wheat and corn that we have in cultivation. It would appear that the plants originally selected must have been mutations or biotypes. Certain it is, they represent distinctly different types which transmit their characters. Here as in the tests of the selected individuals by clonal propagation the character of light or heavy yield is strikingly transmitted. The record of the average yield per plant of 5 light-yielding and 5 heavy-yielding plants is given in Table I and will indicate the transmission through seed of these characters. (See Table I, column marked "Average yield per plant of progeny by seed propagation." These records are from inbred seed of the same original mother plants, the average yield of which by clonal propagation is given in the preceding column.)

Tests of New Varieties of Timothy.—The experiments described above have shown that when the plants are grown in rows, with all the space which they require for full development around them, they transmit their good qualities, such as yield, and are to be regarded as stable or fixed varieties. The grower will immediately inquire whether these qualities of differences in yield are shown when the different sorts are grown by broadcast sowing in the ordinary way, for of what value are they unless their good qualities are maintained under ordinary methods of cultivation?

To test the different sorts under ordinary conditions, open-fertilized seed, thus probably somewhat mixed, was sown in test plats in comparison with similar check plats of ordinary timothy. The open-fertilized seed of the 17 new sorts was taken from rows of these varieties propagated from bulbs and while not isolated was very much less subject to crossing than where one plant of a type stands alone in a mixed field. The later experience with the plats grown from this seed has shown that there was little crossing, as the plats of the different sorts clearly show their different characters, such as lateness and earliness, color and form of head, and the like.

The seed used for the check plats in these experiments was purchased from a local seedsman and was the best timothy seed which he supplied to his trade. The plats were 1 rod wide and 4 rods long, thus one-fortieth of an acre, and every fourth plat was used as a check and planted with the ordinary timothy seed. These plats were sown in the fall of 1909 and gave good test yields in 1910 and 1911.

Table II shows the actual yields per acre of field-dried hay obtained from each plat in 1910 and 1911. From a study of this

TABLE 2.—*Showing yields of 17 new varieties of timothy in comparison with ordinary timothy.*[d]

Plat No.	Parent No.	1910 yields in pounds.			1911 yields in pounds.		
		Yield per acre.	Check yield per acre estimated.	Gain in yield.	Yield per acre.	Check yield per acre estimated.	Gain in yield.
		pounds.	*pounds.*	*pounds.*	*pounds.*	*pounds.*	*pounds.*
C 1831	Check	5280	5280		5400	5400	
1832	1606	6720	5410	1310	6880	5050	1830
1833	1611	7000	5540	1460	7760	4700	3060
1834	1620	6680	5670	1010	7040	4350	2690
C 1835	Check	5800	5800		4000	4000	
1836	1627	7680	6000	1680	8320	3990	4330
1837	1629	8320	6200	2120	8080	3980	4100
1838	1630	7600	5400	1200	7320	3970	3350
C 1839	Check	6600	6600		3960	3960	
1840	1653	7440	6790	650	7680	4050	3630
1841	1668	6040	6980	−940	7160	4140	3020
1842	1671	7640	7170	470	7240	4230	3010
C 1843	Check	7360	7360		4320	4320	
1844	1676	8200	7260	940	8280	4140	4140
1845	1684	7280	7160	120	6920	3960	2960
1846	1687	7600	7060	540	6080	3780	2300
C 1847	Check	6960	6960		3600	3600	
1848	1715	8000	7120	880	8040	3560	4480
1849	1722	7240	7280	−40	6280	3520	2760
1850	1743	7520	7440	80	5880	3480	2400
C 1851	Check	7600	7600		3440	3440	
1852	1745	Road put through this plat.				3560	
1853	1748	6520	7440	−920	5280	3680	1600
1854	1777	9200	7280	1920	7360	3800	3560
C 1855	Check	out			3920	3920	
Average yield 17 new sorts.		7451 lbs. per acre			7153 lbs. per acre		
Average yield checks.....		6600 lbs. per acre			4091 lbs. per acre		
Actual average increase...		851 lbs. per acre			3062 lbs. per acre		

[d] In the above table the column headed "Check yield per acre estimated" may need explanation. The comparison of two plats grown side by side may not be fair, as the land changes somewhat even in one rod. We desire to get as nearly as possible an estimated check yield for each plat of what the check seed would have given if sown in that plat. Taking a specific illustration, in 1910, check plat 1831 yielded 5280 pounds per acre and the next check plat 1835 gave 5800 pounds per acre. Evidently for this season the land is getting better as we proceed toward the second check, plat 1835. The difference between the two checks is 520 pounds. In every four plats there is one check and one-fourth of 520 pounds is 130 pounds. Now if we add 130 to the yield of plat 1831 we get the estimated check yield for plat 1832 which is 5410 pounds. Adding 130 pounds to this gives us 5540 the estimated check for plat 1833. This will probably make the method clear. The correction number between each two checks will obviously be a different number in most cases.

table it will be seen that in 1910 three of the new sorts, 1841, 1849, and 1853, produced less than the yields of their estimated checks but that in the other cases the yields were much in advance of the checks. In this year all of the 17 new sorts gave an average

yield of 7451 pounds per acre, while all of the check plats gave an average yield of 6600 pounds per acre. The new varieties, even including three two low yielders, gave an average increase of 851 pounds per acre.

In 1911, which was in general a less favorable season for timothy, all of the new sorts showed substantial gains over the checks. In this year the average yield of all of the 17 new sorts was 7153 pounds per acre, while the check plats gave an average yield of only 4091 pounds per acre. The new varieties in this year thus gave an average increase per acre of 3062 pounds, or over $1\frac{1}{2}$ tons per acre.

The reason for the decrease in the check plats in the second season is clear to one who has followed this work. Ordinary timothy rusts badly and owing to lack of vigor is comparatively short-lived. A large part of the decrease is due to these causes, but it is also in some measure due to the poorer season. On the other hand, the new varieties are selected for vigor, rust resistance, and ability to stool, and they would naturally increase in size for three or four years and would gradually cover the ground more thickly. These varieties were clearly cut down by the poor season, or they would have given a better yield the second year than the first. Throughout this experiment, which was made as uniform for every plat as possible, the new varieties have clearly shown their superiority in greater height and thicker development on the ground (see Plate V). It may be stated furthermore that several hay dealers belonging to this Association who have visited the plats have stated without reservation that the quality of hay produced by the new sorts, owing to the retention of a fresh green quality and leafiness, would be much superior to that on the check plats of ordinary timothy.

What do these New Varieties Mean?—It may seem surprising to those unfamiliar with breeding that such striking results can be obtained in so short a time. It is truly rather remarkable, but is in no sense a greater increase than would be expected under the conditions. When we remember that timothy is one of the most general crops grown in the civilized countries of the world and that it has been cultivated for about two centuries under very widely differing conditions of soil and climate, we can see that every opportunity possible has been furnished for the stimulation of variations. We now know that a variation once produced is rarely lost in nature but usually is added to the total character variations of the species. Through many years and over millions and millions of acres, among countless billions of plants, these variations have been accumulating, with

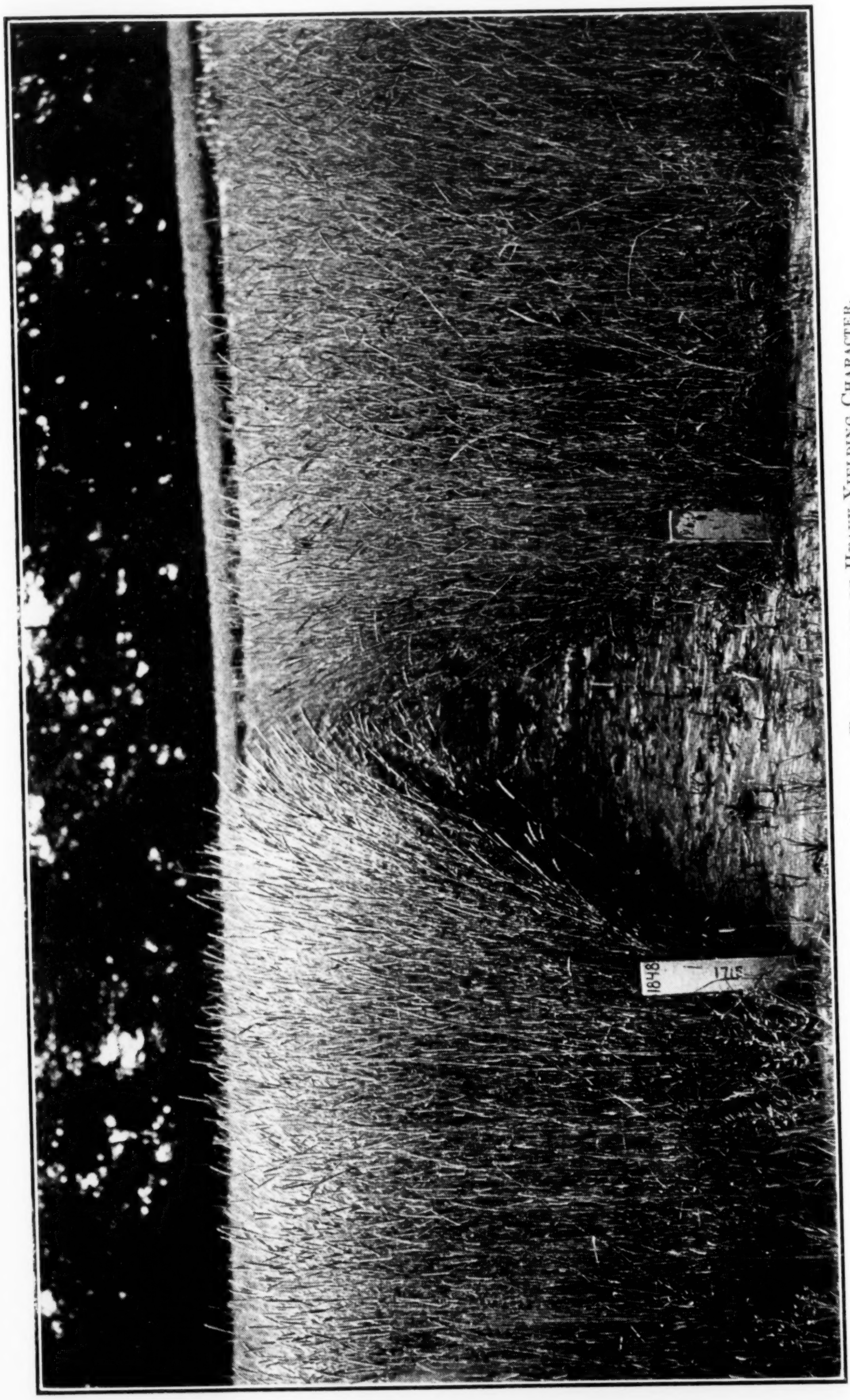


PLATE V.—BROADCAST PLATS SHOWING TRANSMISSION OF HEAVY-YIELDING CHARACTER.
On left, new variety; on right, ordinary timothy.

no attempts to isolate them and use the best for the foundation of improved races for cultivation. Is it any wonder then, that with this accumulation of material by selecting the best variations we get races that yield nearly double the mixture of all sorts of types?

Suppose, for comparison, apples had not been bred for the last two centuries and we had a 40-acre orchard planted with all sorts of variations taken at random, including the worthless wild types and all other sorts such as would have been produced in this period of cultivation without selection. What would be the comparison of value between the crop of such an orchard and the crop from a similar 40-acre orchard planted with Northern Spy or any one of 500 of our good modern varieties? The crop from the unselected varieties would in large measure be wholly unsalable in our modern markets. Probably not more than one-sixth of the crop could be sold for any purpose, and it is doubtful whether even one one-hundredth of the crop could be compared with our modern sorts. If we compare the results obtained in timothy, therefore, with a similar illustration in apples, we can readily see that the timothy results, as obtained in the experiments described above, are no greater, if as great, as we might expect. Indeed the writer feels that only a beginning has been made up to the present time.

Hay is among the three largest agricultural crops of the United States, in total value of production. In 1910 according to the statements issued by the United States Department of Agriculture there were grown in the United States 45,691,000 acres of hay which yielded a crop having a farm valuation of $747,769,000. No statistics are available from which we can determine what proportion of this hay was timothy, but the writer believes that we may safely conclude that at least one-third of the entire hay crop of the country is timothy. If this is true the timothy crop of the United States in 1910 had a valuation of over $249,000,000. In the two years during which tests have been made the 17 new sorts gave an average increased yield of slightly over $36\frac{3}{5}$ per cent above ordinary timothy. A $36\frac{3}{5}$ per cent increase in the valuation of the timothy crop as above estimated would give us over $90,000,000 as the estimated annual gain in the value of the crop which would be obtained if equally good new sorts could be used throughout the country.

Such figures it must be remembered are simply estimates and mean but very little other than to give us quickly a comprehension of what such experiments under ideal conditions might mean to the country. The writer would state very emphatically, however, that

he believes it would be entirely possible to increase the yield of the crop to this extent if it were possible to have every field of timothy in the United States sown with the one of these new varieties best adapted to the conditions. In New York, which is the largest hay-producing state in the Union, and where these varieties have been developed, their introduction into cultivation should result in a marked increase in the average yield.

When can Seed of the New Sorts be Obtained?—For the next two years it is probable that every seed of the new varieties available will be grown to increase the supply. Every effort will be made to get these varieties into the hands of growers at the earliest possible date. While timothy increases very rapidly, a considerable period must necessarily intervene before the seed will be available in large quantities. The writer would request that growers do not write for seed at the present time, as it cannot be supplied.

METHODS OF CORN BREEDING

H. K. HAYES

Connecticut Agricultural Experiment Station, New Haven, Conn.

The purpose of this paper is to bring before the association some further evidence to show that practical corn breeding does not at present take advantage of its full possibilities.

We now recognize two main types of variation: the one which is germinal and transmits its characteristics to later generations and the other which is due to environmental conditions and is not inherited. The type which is heritable is of most importance to the breeder.

The excellent work of Johannsen, which has been corroborated by many other investigators, shows that commercial varieties of plants are composed of many types which by selection can be isolated and which will breed true to type. These types have been called "types."

The types of Maize.—The work of Shull and East shows that any variety of corn is composed of many types. Further evidence on this point has been obtained in the last few years at our station in connection with a study of inheritance in maize. For this purpose it has been necessary to use a number of inbred families. The most interesting of these from the standpoint of biotypes in maize are five inbred strains which originally came from the same

commercial variety of Leaming. These types have been given the numbers 6, 7-1, 7-2, 9 and 12 respectively. No. 9 is a pure red-silked form, but all the others have white silks. No. 6 and No. 9 are erect in habit of growth and have strong sturdy stalks, while the two 7 types and No. 12 are more slender in habit, being more easily blown down by the wind. No. 6 has a cylindrical ear, No. 9 a conical ear, while both the 7 types have flattened ears. Nos. 6 and 9 have a modal class of 16 rows, No. 7-1 a modal class of 20 rows, and No. 7-2 of 22 rows.

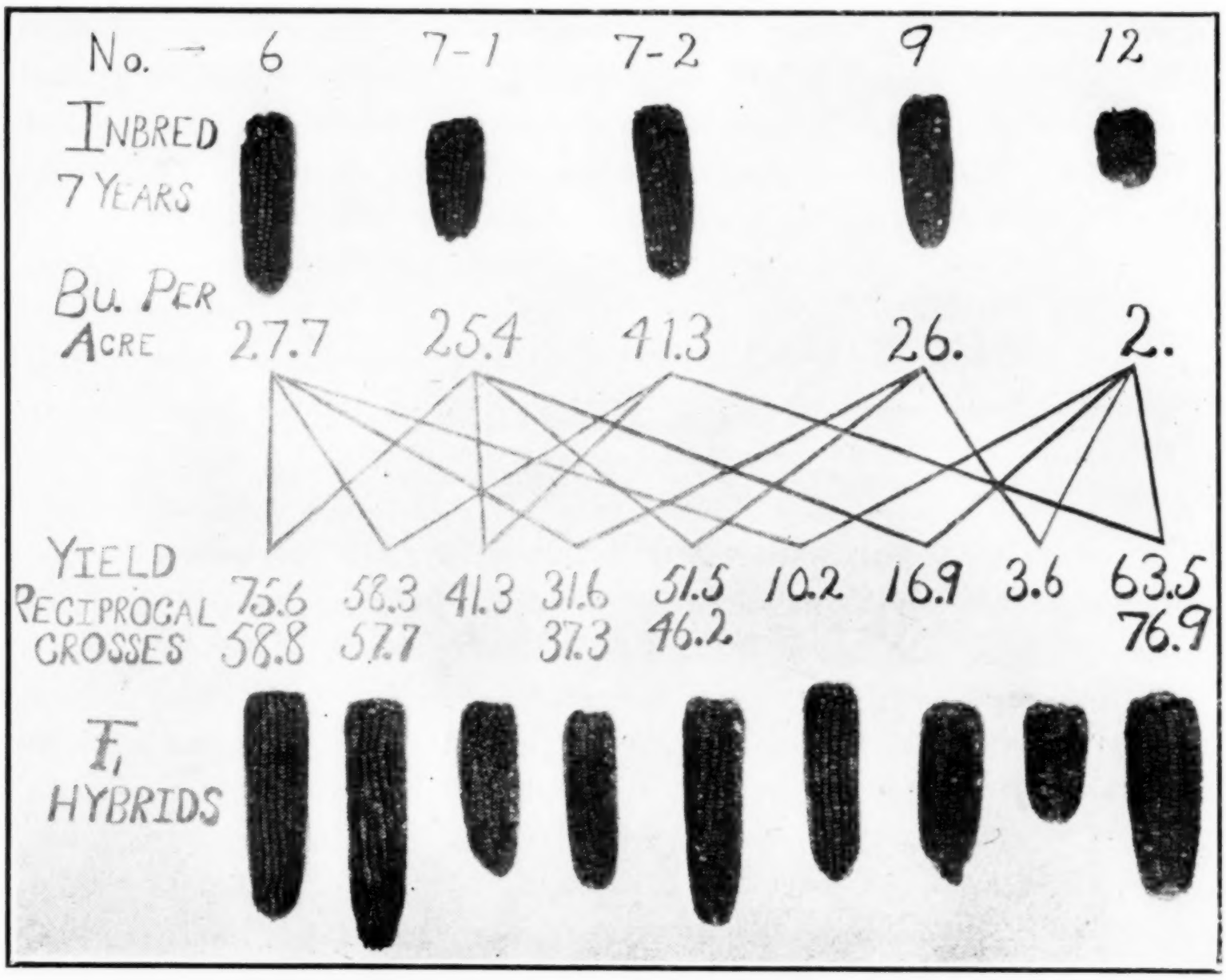


FIG. 1.—HYBRID STRAINS AND FIRST GENERATION HYBRIDS.
The lines between the inbred and hybridized series show the parentage of the latter.

These data show that in certain characters these types have measurable differences, besides others of course which cannot easily be either described or measured.

These inbred types have differed also in their yielding capacity and the average height of plants, as is shown in Table 1, which gives the number of generations each has been inbred, the yield in shelled corn figured to an acre basis and the average height of plants in inches.

TABLE 1.—*Yields of inbred strains for 1911.*

No.	Number of years inbred.	Bushels of ears per acre.	Height of plants.
6	5	27.7	86.7
7-1	5	25.4	81.1
7-2	5	41.3	90.5
9	6	26.0	76.5
12	6	2.0	81.8

In 1911 these inbred types were grown on a level plot of land at the experimental field but the season was so dry that the yields were much less than those of a normal year. All gave fair yields, however, except No. 12, which is a very poor yielding strain and can scarcely live when isolated.

That continuous selection may eventually reach the same goal as inbreeding is fast becoming evident. On the same plot of land with the inbred types four selections were grown from seed kindly furnished by Smith of Illinois. These were the Illinois erect, declining, high and low ear strains. The high and low ear strains bred true to their respective types. The main difference in the erect and declining ear types, as has been pointed out by Smith, is in the number of nodes to the ear shank. The yield of these four selections is given in Table 2, and averages about the same as that received from the inbred varieties previously mentioned.

TABLE 2.—*Yield of Illinois selections grown in Connecticut.*

Illinois strains.	Number of years selected.	Bushel per acre.
High ear	7	26.2
Low ear	7	18.8
Erect ear	6	32.6
Declining ear	6	42.9

That the same results can be more quickly reached by hand pollination than by continuous selection is confirmed by two strains of white rice pop which the writer has been able to isolate from a commercial white rice pop variety in two years by hand pollination. One of these strains has a very short ear shank and erect ear, while the other has a much longer ear shank and a declining ear. These strains appear more uniform than the Illinois erect and declining ear selections.

Effects of Inbreeding on Corn.—There is an old idea that inbreeding decreases vigor and will eventually run out a race, but the accumu-

lated evidence so far of the effects of inbreeding in corn does not show such results. The facts of the case seem much better stated by saying that F_1 hybrids between two different types are as a rule very vigorous; that inbreeding does not run out a race but isolates biotypes and that some biotypes can scarcely live unless in a state of hybridity. This may seem like stating the same thing in two different ways, but attention is called to the fact that in the latter case the type after being isolated will not be further affected by constant inbreeding.

Crosses between Biotypes.—The fact that a cross between two different types is very vigorous in the F_1 generation has been alluded to by many scientists. Darwin in his *Cross and Self-fertilization in the Vegetable Kingdom* gives many examples of such increased vigor. Mendel, the discoverer of the only known law of heredity, mentions the fact that a first generation hybrid between two of his sweet pea types grew more vigorously and to a greater height than either parent.

In two crosses between tobacco varieties which the writer has observed, the F_1 generation for all characters studied except the number of leaves per plants showed an increase in vigor due to the crossing. With cigar wrapper tobacco, however, quality is the important factor and F_1 crosses do not give as good quality as the parent types.

With corn, however, the important thing from a practical standpoint is total yield in bushels of ears and tons of stover per acre. Reasoning from this standpoint, three writers published articles in 1909 suggesting that some method for utilizing the added vigor due to crossing should receive commercial trial. Shull and East from their studies of inheritance in maize concluded that some method whereby only first generation hybrids be grown for the commercial crop would prove of advantage and materially increase the present yield of corn per acre.

Many examples have been collected by Collins of the Department of Agriculture showing that, as a rule, the F_1 generation crosses of corn prove better yielders than the parents. Some crosses do not prove beneficial, however, and it seems important to determine the reason for this.

Reciprocal crosses were made in 1910 between the inbred types shown in Table 1 and this year were grown on a level plot at our experimental field, the results being given in Table 3. In this table the female parent comes first and a cross between No. 6 and No. 9 is written 6×9. A row consisting of 79 hills, 3 stalks to the hill,

was used for each cross. As has already been mentioned, the season was unfavorable and the dry weather materially decreased the yield; however, all crosses had an equal chance. All crosses gave large increases in height over the inbred types, but some were more productive than others.

TABLE 3.—*Reciprocal crosses.*

No.	Bushels of shelled corn per acre.	Height of plants in inches.
6 × 7-1	75.6	111.4
7-1 × 6	58.8	114.5
6 × 7-2	58.3	117.8
7-2 × 6	57.7	
6 × 9	31.6	109.3
9 × 6	37.3	109.
6 × 12	10.2	115.4
7-1 × 7-2	41.3	103.7
7-1 × 9	51.5	111.8
9 × 7-1	46.2	107.4
7-1 × 12	16.9	
7-2 × 12	63.5	114.7
12 × 7-2	76.9	114.0
9 × 12	3.6	103.6

It should be noted that the selections 7-1 and 7-2 are very similar and were isolated from strain No. 7 after it had been inbred for three years. A study of the previous table tends to confirm the following facts.

(1) Reciprocal crosses are equal within the limits of fluctuating variability. This fact shows that we are dealing with very nearly pure biotypes.

(2) All crosses between pure biotypes are not beneficial. Note the crosses between 6 and 12 and 9 and 12 which are poor yielders. It is interesting to note that these crosses had as one parent a type, No. 12, which in a state of self-fertilization was scarcely able to live.

(3) Crosses between nearly related types show little benefit from crossing. 7-1 × 7-2 only gave a yield of 41.3 bushels, the same yield as received from No. 7-2 when self-fertilized.

(4) Some crosses are much more vigorous than others. Reciprocal crosses between 6 and 7 and between 7 and 9 are good combinations.

Nos. 6 and 9 are without doubt more similar in characteristics than 7 and 6 or 7 and 9.

It seems very probable that those types which differ in the greater number of characteristics will prove, as a rule, the better for cross-

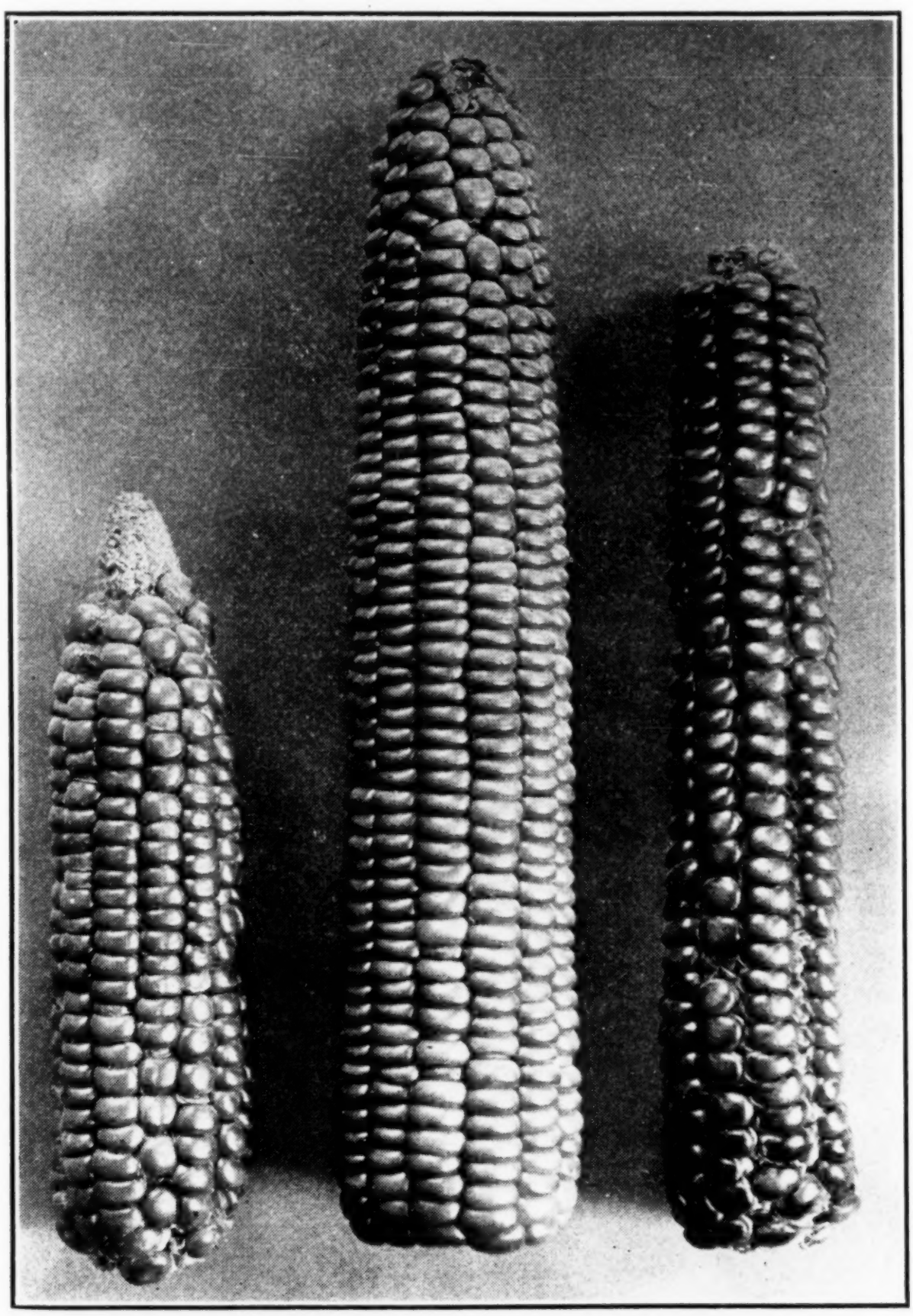


FIG. 2.—Outer ears inbred one generation. Middle ear result of their crossing, first generation.

ing. It should be recognized, however, that poor genotypes should be eliminated by selection.

Comparison of F_1 and F_2 Generations.—Two comparisons of the yield of F_1 and F_2 generations of biotype crosses were made in 1910. The F_1 generation of a cross between a dent and flint type yielded at

the rate of 105.5 bushels per acre, while the F_2 generation grown on the same field produced only 51.5 bushels. The F_1 generation of a cross between two Leaming strains produced at the rate of 117.5 bushels per acre, although the F_2 generation yielded only 98.4 bushels.

These data show that the greatest stimulus to development from crossing two distinct types is obtained only in the first hybrid generation. This necessitates making the cross each year. The explanation of the decrease in vigor in the second hybrid generation is exactly the same as the explanation of the apparent deterioration when corn is inbred. Both are caused by recombinations of characters among which some "pure type" individuals are obtained. In inbreeding the apparent deterioration is more marked because the percentage of such individuals is likely to be much greater.

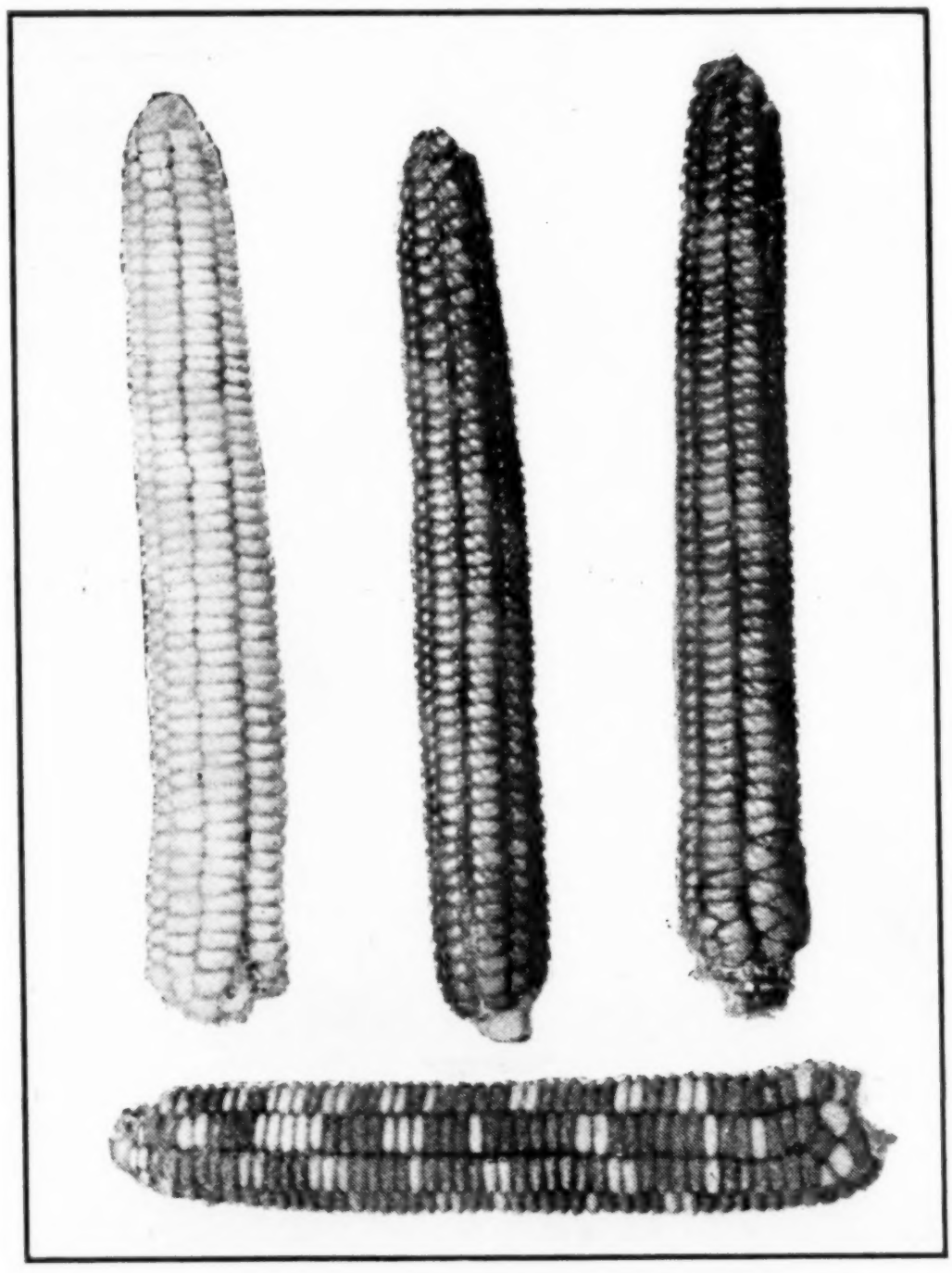


FIG. 3.—The middle ear is the result of an immediate cross between a white and yellow variety and the lower ear shows what would be obtained if such parents were used to produce a first generation hybrid.

Crosses between Varieties.—Whether crossing of pure biotypes will prove of greater value than crosses between highly selected varieties is as yet an unsettled question. Many of our corn varieties have been grown for long terms of years under the same conditions and have been gradually selected to some type. Crosses between such varieties give, as a rule, increases in the F_1 generation. The following table gives the results received at our station and shows that F_1 generations are usually more vigorous than the parents. The first two crosses of this table were grown in 1908 and the remainder in 1911.

TABLE 4.—*Crosses between varieties and their parents.*

Selection.	Yield in bushels of shelled corn per acre.
Longfellow Flint	72.0
Illinois High Protein	121.0
Cross	124.0
Stargis Flint	48.0
Illinois High Protein	121.0
Cross	130.0
Conn. Top Over Flint	58.3
C. T. O. × Canada Flint	65.3
Woodbridge's Canada Flint	72.9
W. C. × Watson's White Flint	80.0
R. I. White Flint	62.2
R. I. W. × Mammoth White Flint	69.3
Stadtmueller's Leaming	75.7
S. L. × Reid's Yellow Dent	99.9
Brewer's Dent	77.6
B. D. × Early Dent	94.7
Longfellow Flint	60.5
Longfellow × Ives	69.1
Ives × Longfellow	63.5
Ives Flint	69.5

The varieties used in the above table are, as a rule, very pure to type. It will be noted that in some cases only one parent is given. This is due to the fact that these crosses were made by Connecticut farmers and seed could only be obtained from one parent. Where the cross has been grown both at the station and by the farmer who made it the average of the two tests has been used for comparison.

Summing up the crosses given in the above table and where both parents were grown, using the better yielding parent, we find that the average yield of the parents is 82.3 bushels per acre, while the average yield of the F_1 hybrids is 91.0 bushels. Thus we have an average increase of 8.7 bushels per acre for the crosses.

As the crossing of two corn types is such an easy matter and can be done on any farm it seems very desirable that further crosses

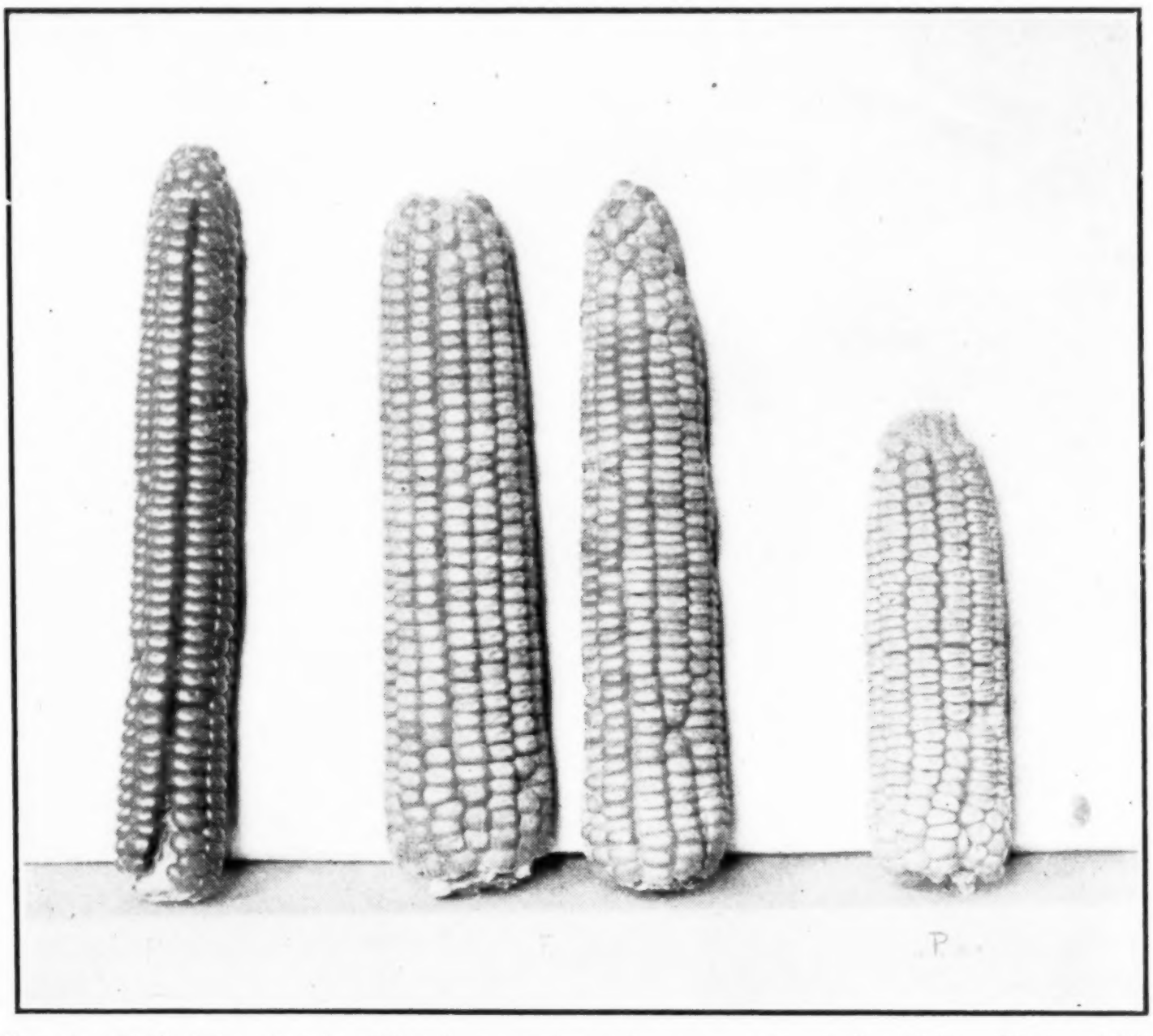


FIG. 4.—At the left and right of the photograph are shown respectively Longfellow Flint and Illinois High Protein Dent. The two central ears represent the F_1 generation. This is the first cross of Table 4.

should be made to determine, if possible, what varieties are the most valuable to use as parents.

Conclusion.—The utilization of F_1 hybrids in corn breeding will materially increase the corn yield.

Selection is of importance in isolating the better types and ridding the variety of the poorer types.

The highest yields of corn will be received from carefully bred selections which when crossed prove the most vigorous combinations by actual test.

LITERATURE CITED

COLLINS, G. N.

1909. The Importance of Broad Breeding in Corn. Dept. Agr. circular.

1910. Increased Yields of Corn from Hybrid Seed. Dept. Agr. Year Book, pp. 319–328.

EAST, E. M.

1909. The Distinction between Development and Heredity in Inbreeding. Amer. Nat., 43, 173–181.

EAST, E. M. and HAYES, H. K.

1911. Inheritance in Maize. Conn. Exp. Sta. Bull. 167, 1–142.

HAYES, H. K., and EAST, E. M.

1911. Improvement in Corn. Conn. Exp. Sta. Bull. 168, 1–21.

JOHANNSEN, W.

1909. Elemente der exakten Erblichkeitslehre. *Jena*. Fischer. Pp. 1–515.

SHULL, G. H.

1909. A Pure Line Method of Corn Breeding. Amer. Breeders' Report, iv, 296–301.

1911. The Genotypes of Maize. Amer. Nat., 45, 234–252.

SMITH, L. H.

1910. Increasing Protein and Fat in Corn. Amer. Breeders' Report, v., 5–11.

THE BREEDING OF WINTER BARLEYS

H. B. DERR

Washington, D. C.

History of the Work.—The work in cereal breeding in the Department of Agriculture was inaugurated a number of years prior to the establishment of the office of grain investigations, which now conducts that line of work. The breeding work was first established at Garrett Park, Md., in 1895, by Mr. M. A. Carleton, the present cerealist of the Department of Agriculture, and consisted principally in the production of disease-resistant strains of cereals. A few years later the work was transferred to the Agricultural Experiment Station at College Park, Md., and in 1902, Mr. H. A. Miller, formerly of this office, was placed in charge of winter cereal breeding. In 1902 Mr. Miller planted 22 varieties of winter barley and in the spring of 1903, 59 varieties of spring barley. This work he continued until 1906, when the writer became associated with the Office and has since conducted the experiments and breeding work.

The negative results obtained with spring barleys by both Mr. Miller and myself demonstrated the inadvisability of continuing

experimental work with them. It was clearly proven that, for the South Atlantic States at least, climatic conditions were against their successful cultivation, and since 1907 all our energies have been directed toward the improvement of the winter barleys. In 1907, the breeding work with cereals having assumed rather large proportions, it was removed to the Department of Agriculture's experiment farm at Arlington, Va., opposite Washington, D. C., and has since been conducted there. In our efforts to produce better-yielding varieties of barley we have succeeded, during the past four years, in chang-

EXPERIMENTS WITH BARLEY ARLINGTON FARM, VA., NOVEMBER, 1909.

This illustration shows the winter habit assumed by the different varieties. The taller plants are spring barleys being changed into winter forms. The low spreading form is that taken on by the regular winter varieties.

ing 16 of the leading spring barleys, such as Chevalier, Hannchen, etc., into winter forms (see illustration), and in several cases they are outyielding the standard winter barleys, of which 29 are under test. The breeding and testing of winter cereals occupied over 13 acres of space the past year.

Crossing of Barleys.—During the past seven years a number of crosses have been made both by Mr. Miller and myself, and from some of these crosses excellent practical results have been obtained.

As these results are to be published in bulletin form only a few of the lesser details can be given here.

Several of the most important crosses were made before the writer became connected with the work in 1906, consequently he knows but little of the character of the mother plants. In 1907, among the large number of variations produced, several attracted attention owing to their peculiar plant characters. The plants from one selection from the cross Tennessee Winter ♀ six-rowed, with Black Arabian ♂ two-row were especially noticeable. Several plants produced heads which, while they resembled two-rowed barleys, were not typical. The median spikelets were fertile and produced plump kernels with medium long awns, while the lateral spikelets were nearly all infertile with the exception of a few almost rudimentary kernels with short, bristly awns. These small lateral kernels were selected and planted in a head-row test, and the following year, 1908, produced plants, a number of which bore heads similar to those of the year previous but containing a much larger percentage of lateral kernels, the majority of which were almost entirely awnless. These were again carefully selected and planted in head-row tests, and in 1909 one of these selections produced 16 plants on which the heads were entirely awnless. Several other selections produced awnless plants but these strains were later discarded. In the fall of 1909 the heads from each of these 16 plants were planted in separate rows for comparison. In 1910 only three heads produced plants having bearded heads. These entire strains should have been destroyed and future annoyance thus averted. In September, 1910, over five hundred head selections were planted in the breeding plat and some interesting data are being compiled relative to the height, number of culms, length of head, etc., of the daughter as compared with the mother plants. Seed of this awnless barley was distributed to a number of reliable coöperators in the south in order to test the influence of environment.

Most of the plants bred true in 1911, but in a few cases the impure blood of the 3 plants that showed traces of bearded characters in 1910 appeared among the plants. By means of an index system adopted, the writer easily traced the record of the progeny from each plant through each generation back to the mother plant, and all the progeny from these 3 plants will be discarded.

It is believed that there is a great future for this barley. It stools heavily, has stiff erect culms and gives all indications of being an excellent yielding variety. Pedigreed seed of the awnless barley has been sent to nearly all the experiment stations and farms in

the northern states, with the request that it be sown next spring in an effort to change it into a spring form. With careful selection this is believed possible in 3 years.

The awnless hybrid was given a name and number and is now known as Arlington Awnless Barley, G. I. No. 702. It was described in Science, Vol. XXXII, No. 823, October, 1910, and the type specimen and description deposited in the economic herbarium of the Department of Agriculture at Washington.

Hull-less Hybrid.—A hybrid has also been produced between Maryland Winter and Hankau, a bearded hull-less spring barley. This hybrid known as Hansee Hull-less, G. I. No. 703, has bred true for two years, and is a hardy bearded hull-less winter barley. The bearded hull-less barleys are adapted to the higher elevations of the western and southwestern states. This seed is being distributed wherever it is thought likely to succeed. Winter barleys generally outyield the spring barleys and, in localities were they can be grown, the quality is superior and the weight per bushel heavier.

Hooded Hybrid.—Owing to the fact that, with the production of the Arlington Awnless barley, there were two distinct types of beardless barley, it was considered necessary to adopt another name for the common beardless barley. As this variety was not entirely awnless, having a three-pronged, hood-like appendage, the name "hooded" barley was proposed for it, the name "awnless" being restricted to the Arlington Awnless barley. These names will be used by this office in the future.

In the South Atlantic States hooded (beardless) barley is quite popular, as it yields a highly palatable and nutrituous hay. In general, this has been a spring-sown crop, with the result that only under extremely favorable conditions can a crop of grain be produced therefrom. The necessity for a reliable winter form of hooded barley was so apparent that crosses were made. After several years of selection, the good qualities of one of the hybrids became apparent and it was named Virginia Hooded barley, G. I. 648. The seed is being distributed to reliable coöperators for further increase.

Standard Varieties.—There have been several standard varieties of winter barley cultivated in the Atlantic and Southern States, but, previous to 1900, little or no effort was made to improve them. In 1900, the Tennessee agricultural experiment station began the breeding of winter barleys, and in 3 years, wrought a considerable change in yield and quality. This was about the time that Mr. Carleton began the work at College Park. Excellent results have attended the work of this office since that time.

Since 1907 a large amount of selected seed of winter barley has been distributed. It may be thought that once having established a pure race the work was done, but with such factors as planting at the wrong time, or by improper methods, or last but not least the mixing due to the traveling thrashing machine, pure races among the farmers soon undergo decided changes and breeding and selection must, of necessity, be done over again.

The three varieties of winter barley that have been selected are Tennessee Winter, Maryland Winter, and Wisconsin Winter. The first two are, without doubt, similar strains from the original winter barley introduced by the early colonists many years ago. Our limited farm facilities permit only a small acreage of each variety, consequently, when a hybrid or selection has by its increased yield or improved plant characters demonstrated its superiority over the standard varieties, the seed is distributed to reliable coöperators over as wide an area as possible in order to test the influence of environment upon it, as well as to obtain a more rapid distribution of the seed.

In order to keep a line on the pure races, selections are made each year and carried through the series from the head-row test planted one year to the field test harvested four years later.

Reports received from coöperators located in different portions of the winter-barley-producing area all indicate the superiority of this selected seed. The two new hybrid barleys, Arlington Awnless and Virginia Hooded, will no doubt still further increase the popularity of the winter-barley crop owing to their freedom from beards, the most objectionable character of barley. The high prices prevailing the past few years have made barley an excellent money crop but cultivation has been restricted, owing to the offensive beards. In the United States are localities in which barley was formerly grown extensively but where it is now only grown in small quantities. In north central Texas large barley areas have been given over to other crops owing to the fact that farm hands absolutely refused to handle the barley crop. In eastern Tennessee the same condition prevails. Even if the farmer is successful in harvesting his barley many of the thrashing crews refuse to thrash the crop, owing to the beards. While barley straw is readily eaten by cattle, farmers are afraid to use it because of the injurious effect of the beards, consequently oats has largely taken the place of barley in the southern states. The total production of barley in the United States for 1911 was 160,240,000 bushels which was over 13,500,000 bushels less than in 1910. It is probable that if the experiment station workers and those inter-

ested in the production of barley in the northern states would take this awnless winter barley, by selection they would change it into a spring form, without injuring its present high-yielding qualtities. If this were done, it would in a few years increase the total production of barley in the United States 25 per cent, and put at least $24,000,000 more in the pockets of the American farmers.

CONSTRUCTIVE EUGENICS

WILLET M. HAYS

Washington, D. C.

[CONTINUED FROM FIRST QUARTER]

Let us then not have an open country of large estates manned with a semi-peasant class nor with defective classes. Let us rather have the family-sized farm, conducted by two or three workers, and splendidly supporting the farm family, that we may have our best heredity on the land. Let public money be freely used to supply the farm families with good roads, splendid consolidated rural schools, free delivery of mails, parcels post, and all kinds of informational and advisory help, the most important of which is the consolidated rural school. Let the state and nation in every way possible assist the farmers and suburban residents to organize among themselves those coöperative projects which enable them to carry on collectively such selling, buying, and other functions as the individual farmer and home maker cannot alone so well perform. And especially is there needed research and aid to make less burdensome the duties of the mother. If ways could be found of successful coöperation in doing the laundering, the baking, the canning of fruits, the killing of stock and curing of meats, and other heavy work, the genetically best mothers would have further encouragement to live on the land.

In order that the cities as well as the country may be rejuvenated every two hundred years, the eugenic slogan should be "the best people on the land." And there are other similar weighty genetic reasons for building up the suburban regions around about our cities and towns. Here encourage the efficient people of the non-agricultural vocations to live. And the public should provide vocational schools for all youths, that when grown they may be able to sustain superior homes. Low transportation rates for pupils to and from vocational schools is an example of how the public can give a

chance to the youth of suburban families to become efficient. Let the genetic burden be laid on the genetically efficient and give them the means and the security under which they can efficiently perform their task.

The Arithmetic of Mass Improvement.—To illustrate the fact that the improvement of the human race by selection is not, after all, so different from the improvement of animals or even of plants, some arithmetical calculations are offered. Suppose, for example, that we divide our nearly one hundred million people into three orders. Let us place in the first order the genetically best one-fourth, whose children will be the most efficient, and let these be represented by the number 25. Let us place in the second order the genetically medium in value, and let these be represented by the number 50. Then, let us place in the third order the genetically least efficient, and let them be represented by the number 25. Without assuming that to be at present the correct number of individuals per family, let us assume that if the second order, represented by the number 50, have families averaging $3\frac{1}{2}$ in number, this will be sufficient to keep the number intact, so that this 50 of medium genetic value will remain constant at 50 for succeeding generations. Thus there will be two left from the average family for parents of the next generation to take the place of the two who served as parents of the preceding generation. The other $1\frac{1}{2}$ of the average family will be sufficient to represent the number of infantile deaths, the number of non-married, and the number of those married but having no children.

Let us now assume that the best one-fourth have families somewhat larger—say four children per family. By subtracting the $1\frac{1}{2}$ for infantile deaths, non-marriages, etc., we have remaining $2\frac{1}{2}$ with which to produce the next generation where there were only the two parents of the family the preceding generation. This is an increase of one-fourth. By multiplying the 25 by $1\frac{1}{4}$, we have $31\frac{1}{4}$ as the number in the second generation. By continuing this multiplication by $1\frac{1}{4}$ for twelve generations we have 364, while during this entire time the medium one-half remains at 50.

Now, taking the 25 least efficient genetically, let us assume that there is an average of only three children per family. Here, taking out the $1\frac{1}{2}$ for infantile deaths, non-marriages, etc., we have for the next generation only $1\frac{1}{2}$ instead of the two parents of the preceding generation. This is a reduction of one-fourth, leaving each generation three-fourths as large as the last. Multiplying the 25 by $\frac{3}{4}$ we have in the second generation $17\frac{1}{2}$. Continuing this multipli-

cation for twelve generations, we find that this 25 becomes 1, or 0.2 per cent of the whole.

Thus, in twelve generations, or practically 500 years, we have the race made up of 87.7 per cent of the blood of the best one-fourth; 12.1 per cent of the blood of the medium one-half, and 0.2 per cent of the blood of the least efficient one-fourth.

We need not assume that these percentages mean that values would be worked out in exactly these proportions. The illustration is only to show that even with such little differences as an average of one more child per family from the genetically best families than from the genetically least efficient families, the undesirable will gradually become a smaller part and will give the field to the genetically more efficient people.

If instead of four children per family for the genetically best one-fourth we take five children per family and carry out the calculations as above, at the end of five generations, or in two hundred years, the proportions will be, in whole numbers, 410 from the best, 50 from the medium, and 6 from the genetically least efficient; or, expressed in percentage, we have 88 per cent from the genetically best 25, 10.7 per cent from the genetically medium 50, and 1.3 per cent from the genetically least efficient 25. If anything like such a ratio of sizes of the families from the most efficient and the least efficient parents could be maintained, there would be a marked increase in the efficiency of the network of descent in each period of two hundred years, and this could not fail to produce marvelous results in the inherent power of the people in the world.

With all of our studies of heredity we must not overlook the fact that our schools, our churches, and our homes must so conserve moral conditions that normal men and women may be fully developed, with their individual and genetic powers unimpaired as by the racial poisons of alcohol and venereal diseases. In case of intemperance, for example, not only are men ruined by alcoholic beverages who, in the absence of temptation, might be useful citizens and efficient parents, but the impaired vitality which they impart to their children and which they induce by neglect helps to perpetuate the demand for alcohol as a stimulant during the succeeding generation, if indeed, there may not be an actual acquired inheritance of the desire for the specific stimulant. Eugenic pride based on genetic genealogies may eventually greatly lessen the social evil and thus reduce the moral and physical poisoning which is now so widely prevalent. Those who might too critically regard the significance

of the figures above should understand that they are not to be judged from what is commonly termed "mass selection," such as the selection of seed wheat in the fanning mill. It is assumed that the selection would here be genetic, which is not mere mass selection. The basis for comparison in the selecting of individuals would be not so much their individual excellence as the superiority of their genetic power as determined by the average efficiency of their progeny, or as estimated from average efficiency values of their coördinate relations, as brothers, sisters, cousins, and also ancestors.

Some of our scientists who are creating new values by plant breeding have in their plant nurseries hundreds of thousands and even millions of individual plants so grown that each plant stands in a hill by itself, each with its individual number. These technical workers have wrought out plans of utilizing these individual plant numbers as helps in determining the genetic value of each and any plant. Thus they are able to determine in a given standard variety of a given species, as of wheat, the plants which give the largest net value per acre and produce the highest value in the market or in the mill and bake shop, and they are able to find among these best plants the progeny of the occasional mutation. Having found the new mutating stock they can rapidly and readily multiply this into a new and important variety. While such rapid results cannot grow out of systematic efforts applied to the human family, results approximately as rapid as those indicated in the calculations above might be possible. In any event, it would seem quite as proper and important that each person of the family in which we are interested should have a numerical name as that each plant should be so designated in the plant breeding nursery.

A name with eleven letters is not over long. The number 99,000,000,000 has only eleven figures, yet in a series of numbers of that size there could be individual number-names for each of sixty times as many people as now inhabit the earth. At slight cost per name the census bureaus of the world could place in such a single series the number-names of every person now living, every person of whom there is any history, and every person who might be born in the next thousand years. Once instituted, such a system of number-names would go on indefinitely and no two persons would have the same number. If desired, a block of these numbers could be allotted to each country. By exchanging their lists of names and number-names the main bureau of each country would have the

completed series as entered up to date. At relatively small cost the names and number-names of the parents of each person and the number-name of each child born to each person could be added to his own name, also birth and death dates and places, thus giving all needed basic facts regarding his lineage genealogy. These universal world number-names could then be used in lineage genealogies along with any system of family number-names desired, thus placing a means of reference from each genealogical compilation to every other similar compilation.

Private family bureaus, or even public bureaus, could request the census bureau to give each person of their families a lineage number in this world series. The interested family could then give to each member a single number, usually in the form of a percentage, expressing the individual value of the general efficiency of the person. In like manner a single numerical statement, as a percentage, could be used to designate any marked characteristic, as ability in music, or personal beauty, or tendency to obesity. Compilation of these percentages into averages, as of progeny, or of coördinate relatives, so as to give genetic ratings, also in a single numerical statement as a percentage of individuals and of families, would follow the same relatively simple bookkeeping or recording processes that are the common practice in plant breeding and in animal breeding.

Immense importance would soon be attached to these genetic family ratings. Those families with high ratings would be made to realize the importance of mating with those of equal genetic excellence, and the more rapid multiplication of their numbers. The individuals of these families would have a new incentive to gain high personal ratings and to develop their children so that they might merit high ratings, thus preserving and increasing the status of their families. The families of the best genetic blood would be at a premium, especially among other families with high genetic ratings. Again speaking broadly, the best one-fourth of the race would find the world expecting of it not only success as individuals, but that the individuals be multiplied more rapidly than the average. On the other hand, the genetic facts concerning families with definite genetic defects or with such indifferently low genetic efficiency that their members cause public concern and expense, as in eleemosynary institutions, should be publicly recorded. Marriageable members would not be at a premium. The common thought of the people would not place upon this class any large portion of the racial duty of multiplying

the race. They would properly feel that they had better bear fewer children and give especial attention to providing good opportunities for them.

It will be noticed in this discussion that differences are not drawn between small families and large families, but between families somewhat above the average and families below the average. If objection is made that genetic facts will throw society into classes, it must be admitted that the classification will represent efficiency and will not as a rule follow false or mischievous standards. In case of one family where this number-name scheme is used in compiling both the lineage genealogy and the genetic genealogy, many of the plans of determining and displaying the genetic values are already being devised. And doubtless ere long genetics will be showing the breeders of plants and animals even more artful ways than they now have for securing and making plain the genetic values of individuals and families.

Looking at the city, the country, or the world, with its peoples of pure and mixed races, and taking into view the fact that economic conflicts will continue permanently after wars with arms may have ceased, nothing stands out more clearly than the fact that races and families must make their conflicts with large numbers as well as with high averages of individual efficiency. Genetists will have much to do in their study of hybrid races, and with the place of these races in the conflicts among the races of the earth. When the genetist comes to study the great migrations of the races of men, the relation of racial make-up to the economic contests between countries and races, and legislative efforts to avoid or promote the genetic mixtures of races, he will find range for the highest possible wisdom and skill. It has been predicted that neither plant breeding nor animal breeding will eventually develop as highly trained genetists as will be found among those who make a specialty of eugenics.

Genetic knowledge promises to have an important relation to the cost of living and upon the life of the nation. It seems none too much to hope that the science of eugenics will greatly lessen the cost of our eleemosynary institutions, will lead to a better average of efficiency, to the reduction of divorce, to temperance, and to a higher morality. May we not hope that, in addition to increasing the average of intelligence, efficiency, and happiness, eugenics may lead even to a larger production of great geniuses and even to the production of families of special-purpose people? Eugenics as a whole will tend to produce sane, able, well-rounded characters, strong in

their allotted tasks, and good citizens. Who, except the prudish, would object if public agencies gave to every person a lineage number and genetic percentage ratings, that the eugenic value of every family and of every person might be available to all who have need of the truth as to the probable efficiency of offspring?

AN ACCOUNT OF THE WORK OF THE EUGENICS RECORD OFFICE[a]

H. H. LAUGHLIN

Cold Spring Harbor, N. Y.

After having been forgotten and ignored by science for thirty-five years the re-discovery, twelve years ago, of the Mendelian laws of inheritance strongly supported the revolutionary work of Weismann then engaging the attention of those interested in heredity. This combination of forces gave biology a new key to the mysteries of inheritance and caused a renaissance in the study of experimental heredity in plants and animals. Foremost among the workers in this subject in America was Dr. C. B. Davenport, Director of the Carnegie Station for Experimental Evolution. His work with plants and animals had not proceeded far before human heredity began to attract his attention. By the summer of 1910 he had collected nearly three hundred records of family traits describing in considerable detail the family distribution of some thirty specific mental and physical traits. By this time the work had grown so greatly in interest and promise that he was invited to organize and direct an institution devoted solely to research in human heredity and its application to human affairs. This institution, the Eugenics Record Office, of Cold Spring Harbor, Long Island, New York, was duly organized, and as stated at the last meeting of this section by October 1, 1910 was ready for work. The family records collected by Dr. Davenport and referred to above formed the nucleus of the files of the institution which are now growing at a satisfactory rate. The functions of this office are (1) to serve as a clearing house for data on human heredity and its application to human affairs, (2) to build up an index of the American population indexing families, traits and their geographical distribution with special reference to sub-normal and super-normal characteristics,

[a] Read before the Washington meeting of the Eugenics Section of the American Breeders Association at the Volta Bureau, Washington, D. C.

(3) to train field workers expert in gathering data of eugenic import, (4) to maintain a field force actively engaged in collecting such data, (5) to coöperate and to collaborate with persons and with other institutions concerned with human heredity, (6) to study authentic data, thereby discovering the general laws of inheritance and the specific manner of the inheritance of specific traits, (7) to aid and to promote the organization of new centers for eugenic research, (8) to advise concerning the fitness of marriage unions, (9) to disseminate eugenic truths to the end that society may proceed wisely to the application of plans for the betterment of the human stock.

In the first training class—July and August, 1910—ten persons already advanced students of biology and sociology, were trained as experts in collecting first hand data adequate to the needs of eugenic research, and six of these were employed jointly by the Eugenics Record Office and by other institutions. During the second year—July and August, 1911,—another and somewhat larger group of persons were given a similar training, and six more were added to the staff of field workers, thus making the field force reporting directly to the Eugenics Record Office twelve in all. Several other persons were trained during the year, but not in connection with organized class routine, so that in all nearly fifty persons have been given this special training by Dr. Davenport. The next training course will be given at the Record Office at Cold Spring Harbor, from June 26 to August 6. These twelve workers have been gathering data on the family distribution of the following traits: Feeblemindedness, epilepsy. insanity, Huntington's chorea, criminality, juvenile delinquency, vagabondism, hare-lip, haemophilia, cancer, albinism, and skin color. Special studies are also being made in consanguinity, the eugenic import of isolated communities, the old Mormon families of Utah, the present day descendants of the old Juke family, the legal sterilization of degenerates in Indiana. Besides, on these lines data on a host of other traits has been gathered. This material is gotten at first hand in the home territories of the families studied. The absence of a body of facts suited to the intelligent application of Eugenic remedies makes this method of original observation imperative. The field workers chart out as far as possible the complete family network along all ancestral, collateral, and consort lines. They spare no pains to secure an accurate family network, and an equally accurate description of the inborn traits of each member. The facts so gathered are indexed at the Eugenics Record Office in accordance with a system devised by Dr. Daven-

port, and recorded in the book of traits (Bulletin No. 6, Eugenics Record Office, February 1912, C. B. Davenport). This index is an expansive one, and is based upon the decimal system, quite the same as the Dewey Decimal System for classifying books. The first synopsis of traits is as follows:

0. General traits,
   General diseases,
   Occupations.
1. Integumentary System.
2. Skeletal system,
   Muscular system,
3. Nervous system,
   Criminality.
4. Mental traits,
   Movements.
5. Sense organs.
6. Nutritive system.
7. Respiratory system.
8. Circulatory system,
   Lymphatic system.
9. Excretory system.
   Reproductive system.

All record is indexed on a sextuple system, with cards for each of the following combinations: (1) surname-trait, (2) trait-surname, (3) locality-trait, (4) trait-locality, (5) locality-surname, (6) surname-locality, The purpose of this system is to permit investigators to study traits and families and their geographical distribution from the point of view any of these combinations. The efforts of this office are directed toward indexing of all of the defective and sterling germ-plasms of the American population. The making of such an index is an immense task, and will demand the coöperation of many persons and institutions, but its value in the practical application of any scheme looking toward the cutting off of the defective strains of the American population is obvious. But the field worker is not the only source of data. Genealogical, biographical, and medical literatures are being reviewed by the office with the view to extracting data sufficiently biological and detailed in nature to permit of biological deductions. Genealogical records contain, save for data on consanguinity, longevity, and fecundity, but little material of value. Town histories, on the other hand, are much richer from the Eugenic point of view. Medical literature contains a considerable number of authentic family networks, describing in detail the distribution of certain traits and many valuable records have been gotten from this source. The number of physicians and institutions coöperating with the Record Office is gradually increasing. From these sources many pedigrees are secured, but the most valuable records are those of family traits which are still being secured from many splendid normal American families. For this purpose duplicate blank schedules are supplied by the Record Office, one for the files of the office, and the

other for the personal use of the collaborator. Besides this general record of traits, several special schedules have been prepared. Up to the present time these are schedules on (1) alcoholism, (2) hare-lip, (3) musical ability, (4) mathematical ability, (5) Huntington's chorea, and others are in the course of preparation. Any of these blank forms will be supplied to persons interested upon application to the Eugenics Record Office.

One of the most essential parts of the work of this institution is, of course, the study of the data, thereby making it tell the tale of the manner of the inheritance of specific traits. Here, as in other realms of science, the criteria of truth is predicability. Eugenic research seeks to answer this question: Given two parents of known ancestry and collateral kin with reference to a given trait, how will this trait be distributed among their offspring? Such work of reduction is essentially analytical or Mendelian. The mass of biometric methods avail but little in answering this question.

All work of reduction is done either by Dr. Davenport personally, or under his direction, jointly with the field worker, or jointly with the scientists in charge of the research work of the collaborating institutions. Thus far the following publications based in whole or in part upon data gathered by Dr. Davenport or by field workers trained as above described have been issued:

(1) Eugenics, C. B. Davenport (an elaboration of a lecture "Fit and Unfit Matings"). Henry Holt and Company, 1910.

(2) Heredity in Relation to Eugenics, C. B. Davenport (the text book of modern eugenics). Henry Holt and Company, 1912.

(3) Heredity of Eye Color in Man, *Science*, pp. 589, November, 1907.

(4) Heredity of Skin Pigment in Man, C. B. and G. C. Davenport. American Naturalist, vol. 44, November and December, 642–672, 705–731.

(5) Heredity of Hair Form in Man, American Naturalist, vol. 42, p. 341.

(6) Heredity of Hair Color in Man, American Naturalist, vol. 43, no. 508, April, 1909.

(7) Bulletin No. 1, Heredity of Feeble-mindedness, H. H. Goddard. April, 1911.

(8) Bulletin No. 2, Study of Human Heredity, C. B. Davenport, H. H. Laughlin, David F. Weeks, E. R. Johnstone, Henry H. Goddard. May, 1911.

(9) Bulletin No. 3, Preliminary Report of a Study of Insanity in the Light of the Mendelian Laws, Gertrude L. Cannon and A. J. Rosanoff. May, 1911.

(10) Bulletin No. 4, A First Study of Inheritance in Epilepsy, C. B. Davenport and David F. Weeks. November, 1911.

(11) Bulletin No. 5, A Study of Heredity of Insanity in the Light of the Mendelian Theory, A. J. Rosanoff and Florence I. Orr. November, 1911.

(12) Bulletin No. 6, The Trait Book, C. B. Davenport. February, 1912.

Other publications are in progress including one memoir on the "Nam" family, (a pseudonym given to a very inferior family in one of the isolated communities of New York State), based on field work conducted by Dr. A. H. Estabrook of this office, and another in which certain epileptic and feeble-minded families of Massachusetts are studied. This latter is based upon field work by Miss Florence H. Danielson, also of this office.

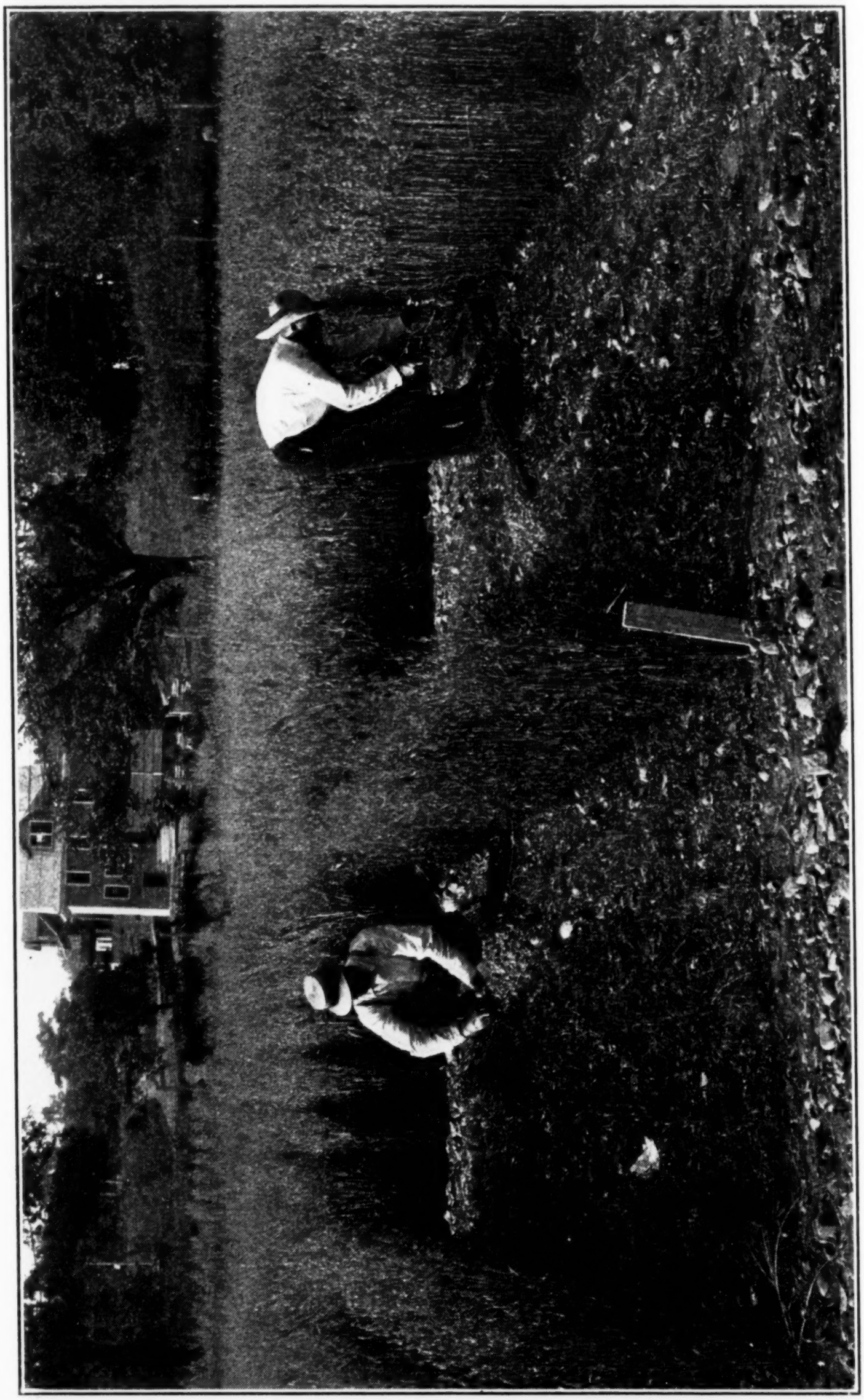
Eugenic research naturally falls into three classes:

(1) The study of the sub-normal strains and the combination of their traits into the types of the socially unfit.

(2) The normal classes and their traits.

(3) The super-normal classes and the traits of talent, special skill, and genius.

After the modes of inheritance of a great many traits have been worked but to a predicable nicety and many of the super-normal and sub-normal germ-plasms of the country has been indexed, it will doubtless be in order for society to devise some means of cutting off the supply of defectives and of bringing sterling germ-plasms together. Such efforts must, however, if intelligently directed, follow, not precede, investigation. Schemes for social betterment must, at first be experimental, but the safest experiments are doubtless based on the teachings of the greatest body of facts. Such a body of facts applicable to eugenic remedies is just beginning to be organized. The present program of eugenics is, therefore, research.



HARVESTING INDIVIDUAL ROWS OF OATS SELECTION. PLANT BREEDING GARDEN, CORNELL UNIVERSITY, ITHACA, N. Y., 1910.

THE EFFECT OF RESEARCH IN GENETICS ON THE ART OF BREEDING

HERBERT J. WEBBER

Cornell University, Ithaca, N. Y.

[CONTINUED FROM FIRST QUARTER]

Our different breeds of dairy animals are maintained in a state of high productivity by continuous selection. Cows are followed carefully with reference to their milk-producing capacity and their ability to transmit this quality to their offspring. The ability of bulls to beget high milk-producing daughters is taken as a test of their value. There can be no doubt, I believe, that this selection within the breed maintains the breed in a state of high efficiency and is absolutely necessary to the success of dairying. Strictly speaking, in the course of this selection, however, no new type has been produced. It is well recognized that continuous selection is necessary to the maintenance of high milk-producing capacity, and if the selection were discontinued the average milk production of any dairy herd would rapidly decline until it reached the normal mean for the breed concerned. The same can not be said, however, of the breed or race characters, that is those characters which distinguish the breeds or races from other breeds. Selection is not necessary to maintain the general characters of the Holstein breed, for, as long as it is not crossed with other breeds, it will in general maintain its characters so far as color, conformation, and dairy type are concerned. The same may be said of any of our breeds of cattle and horses. The high efficiency of our race horses is maintained by the most careful selection and yet probably in most cases no distinctly new character is added which would maintain itself as a unit character in inheritance.

It is true that we are dealing here with complex phenomena and limited exact experimentation and a distinct mutant in the direction of high efficiency might occur at any time and be chosen for breeding which would maintain itself without continuous selection.

It is interesting at this point to recall one of the most common differences between plant and animal breeding which is seldom clearly recognized by practical breeders. Plant breeders most commonly strive to produce new races or breeds with distinctive characters which will reproduce their desirable qualities without continuous selection; while animal breeders almost wholly limit their attention to selection within the breeds already established, to maintain them

in the highest state of efficiency possible. The failure to understand this difference in purpose has frequently led to confusion in our discussions.

It is beyond the scope of this paper to discuss the kinds of variation used in these different types of selection, even if we possessed the requisite knowledge which is doubtful. I may be pardoned, however, for digressing far enough to state that it is my conviction that there is no very hard and fast line between that variation which is in considerable degree inherited, such as is found frequently in high milk-producing cows in selection within the breed, and the mutation which gives absolute inheritance and established a permanent new mode. The great difficulty in determining whether there is any true cumulative action of selection which will extend a character beyond the limits of the race or species is met in determining what are and what are not mutations. My experience has led me to conclude that the continuous selection of maximum fluctuations in a certain direction may in some cases lead to the gradual strengthening of the character until finally it may become, more or less suddenly, fully heritable, and it would then be recognized as a mutation.

In many cases we find exceedingly small differences maintaining themselves generation after generation under different environments when the lines of descent are kept pure. A marked illustration of this is afforded by Mr. Evans' studies on pure lines of *Stellaria* reported at this meeting. The segregation of such characters in hybridization would be exceedingly difficult to recognize if it did occur. Again the occurrence of such small mutants, if we may so designate them, within a breed under selection, if not recognized and isolated, would be crossed with fluctuations and cause variations which would be recognized as regressions in the highly selected strain.

I think it will have become clear from the above discussion that in the present state of our knowledge of selection we can only advocate that practical breeders continue their selections as in the past. This is particularly true in the cases where it is the idea to maintain the race or breed at its highest efficiency. In the case of plant breeders working to produce new races, the mutation theory introduces a new element and leads the breeder to search for a mutant possessing desirable characters which he can isolate and which he may expect will reproduce its characters as soon as he has purified the type from mixtures derived through hybridization with other

types. He will select the type to purify it rather than to augment its good qualities.

Returning again to the question of new characters, we may profitably question more definitely where such new characters come from, if they are not produced by selection. Clearly no problem is of more importance to the breeder than to be able definitely to produce or cause such new characters to appear. If the breeder must await the pleasure of nature to secure the changes he desires, the waiting may be long and tedious. If he must watch thousands of plants of a certain race of species every year in order to find the apparently accidental variation or mutation in the direction of the improvement he has in mind which may rarely or never be found, the process will be so hazardous that we should have to await the accidental discovery of any new characters. Indeed up to the present time we have had practically no other recourse than to await the accidental discovery of such new characters. We, however, have had many theorists and investigators who believed that changed environment would stimulate the production of variations in the direction of better fitting the organism to its environment. Lamarck and his followers have strongly maintained this hypothesis and many scientists even today believe in the effectiveness of environment in developing adaptive changes. Breeders have carried this principle so far as frequently to advocate the growing of plants in the environment most likely to produce the change desired, as, for instance, cultivating tall plants like twining beans in the north or at high altitudes if it is desired to produce a dwarf type or, vice versa, breeding the plants in the south and at a low altitude if a giant or tall type is desired. Weissman and his school of followers have apparently exploded this idea by demonstrating that characters acquired as a result of changed environment are merely physiological changes and are not inherited. The question, however, is by no means settled and we must await further evidence.

Knight believed that increased food supply caused an increase in the range of variation and that it was important for breeders to manure their plants heavily. De Vries, on the contrary, would have us believe that such variations are fluctuations and nonheritable. The studies of Weisse, Reinhold, MacLeod, Tammes, and Love have given us many instances where the range of variation is increased as a result of food supply and other instances where the variation is apparently greater on poor or sterile soil.

It would seem that any treatment that would increase the range

of variation in plants that are grown for breeding purposes would be valuable, but it still remains to be definitely proven whether such increases in the range of variation are in any marked degree heritable and whether valuable maximum variates can be more frequently produced in this way than would be found in similar groups of plants under ordinary treatment.

It is only very recently that the idea has developed that we can go farther than possibly change the environment. With the publication of MacDougal's researches in 1906 describing mutations that were apparently caused by injecting the capsules of plants with certain solutions, such as zinc sulphate, magnesium chloride and the like, a possible new method of forcing variations was introduced. MacDougal apparently obtained, as a result of his treatments marked variations which were inherited in succeeding generations.

Tower, by subjecting potato beetles during the formation of the germ cells to extremely hot and dry or hot and humid conditions with changes of atmospheric pressure, was able to cause the development of marked changes or mutations which were found to transmit their characters true through several generations and which segregated as unit characters following hybridization. He concludes from his experiments "that heritable variations are produced as the direct response to external stimuli."

Gager has produced similar changes in plants by subjecting the developing ovaries of plants to the action of radium rays, and a number of similar studies by Hertwig and others indicate that radium emanations have a very active effect on both plants and animals.

While the evidence favoring the value of such external stimuli as the above in producing new heritable characters is apparently definite and positive, the extent to which the method can be used in practical breeding has not been determined and indeed we must await further evidence before we can finally accept the evidence, or the interpretation of the evidence, presented in these very valuable and suggestive researches Dr. Humbert carried out experiments in my laboratory in which the capsules of a pure line of a wild plant, *Silene noctiflora*, were injected with the solutions used by Dr. MacDougal, and although the number of plants handled (about 15,000) was apparently as great or greater than was used in MacDougal's experiments, no mutations were found in the treated plants which were not also found in the untreated or check plants.

Some observations and experiments are recorded in literature which indicate that mutilations or severe injury may induce the develop-

ment of mutations. Most noteworthy among such observations are those of Blaringham, who by mutilating corn plants in various ways, such as splitting or twisting the stalks, apparently produced variations which bred true without regression and which he described as mutations. My own observations on the great frequency of striking bud variations on recovering trunks of old Citrus trees in Florida following the severe freeze of 1894–5 also furnished evidence in support of this theory.

In general, it is assumed that in hybridization we are dealing merely with characters already present and that new characters which appear are due to the different reactions caused by new associations of unit characters in their mutual effect on one another. It is, however, possible that new unit characters may result from the commingling of the different hereditary units which are to be considered as mutations rather than new combinations. As is well known, Weissman long ago advanced the hypothesis that valuable variations in evolution were due to the commingling of protoplasms from different parents having different hereditary tendencies, a process which he called "amphimixis." He did not have in view, however, the formation of new unit characters as distinct from new combinations.

The most marked case known to me of the appearance of a new character which was apparently caused by the stimulation of hybridization is the development of a marked spur or horn on the lip of a hybrid Calceolaria (fig. 1). This occurred among a series of hybrids between a herbaceous and a shrubby species made by Professor Atkinson and Mr. Shore, of the Botanical Department at Cornell University. One or two tapering horns about an inch in length and from 2 to 4 mm. in diameter at the base spring from the upper surface of the large corolla lip and grow erect to its surface. No such character, so far as can be learned, is known in the Calceolarias and it would seem to have been caused by the hybridization. It cannot, apparently, be considered as a combination of any of the known characters of the species concerned.

Such apparently new characters appear rather commonly among large batches of hybrids, and while there is little evidence available on the subject I am inclined to believe it will be found that hybridization may stimulate the production of new unit characters, which mendelize with the parental types.

While the evidence at our command regarding the artificial production of mutations is not yet sufficiently exact and trustworthy to

enable us to draw definite conclusions and formulate recommendations for practical breeders, it may be stated that this is apparently one of the most profitable lines of experimentation for the immediate future.

Thus far I have only incidentally discussed hybridization and the advance of our knowledge in this direction. The scope of this address will not allow of an adequate treatment of this subject and it appeared wiser to discuss more in detail the problems of selection and variation. I cannot, however, close this address without referring to this very important field of genetics.

No discovery in the field of breeding has had more effect or is more far reaching in its importance than the discovery of what have now

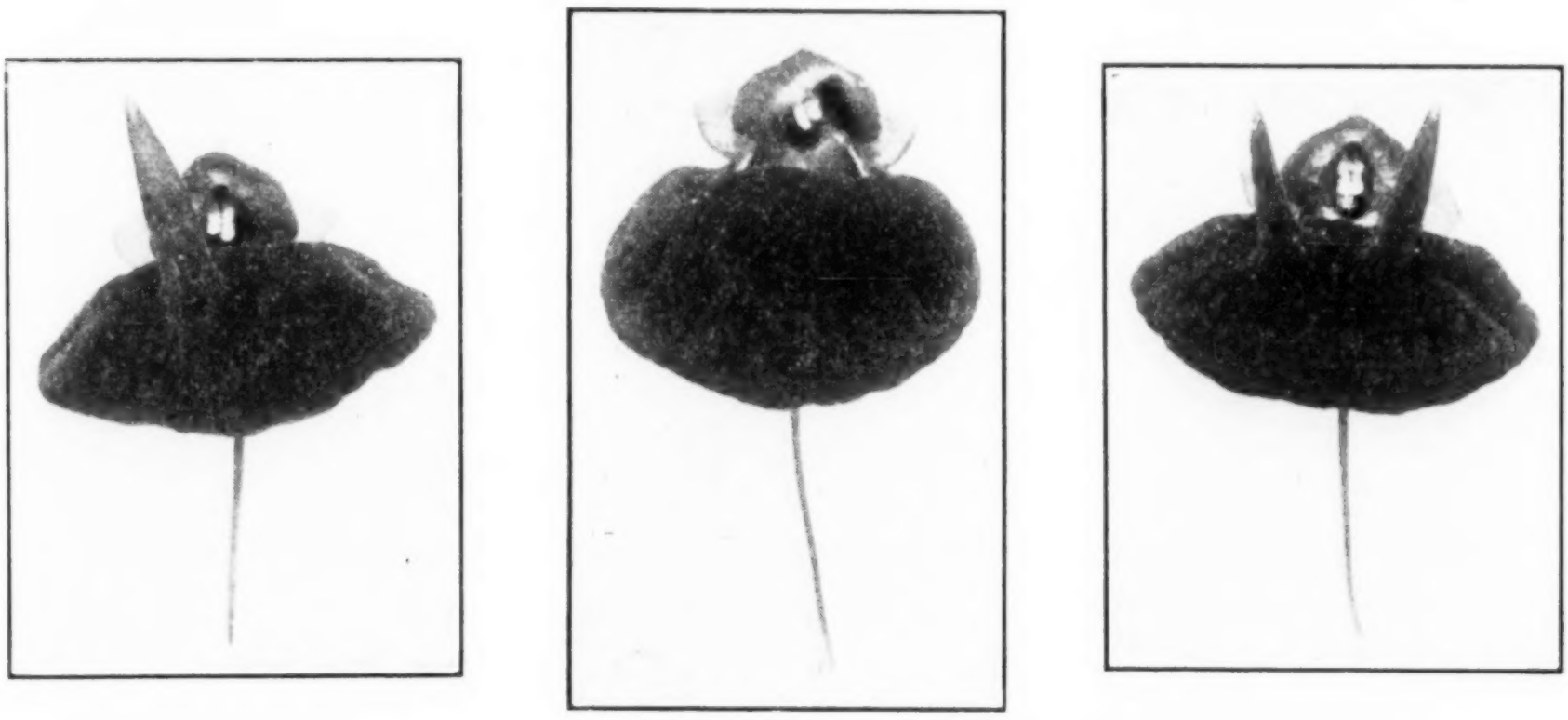


FIG. 1.—HYBRID CALCEOLARIA.
Showing the development of horns or spurs on the corolla lip. (One normal and two spurred flowers natural size).

come to be known as Mendel's principles of heredity. While, as stated in the beginning of this address, breeders had long before the rediscovery of Mendel's papers come to understand that there was a segregation of characters in the F_2 generation and that it was possible to recombine in certain hybrids the desired characters from different parents, there was no definite understanding of the underlying principles, and no conception of the almost infinite possibilities of improvement which the field of hybridization opened to us.

The law of dominance, while not universal, has explained many cases of prepotency in one generation and failure of certain individuals to transmit the character in the next generation. It has explained

many cases of latency of characters and may account for all such cases.

The law of segregation has shown us that the splitting of characters follows a definite method and that we can in general estimate the frequency of occurrence of a certain desired combination, if we know the characters concerned to be simple unit characters.

The study of hybrids has been resolved into a study of unit characters and their relation to each other. By hybridizing related types having opposed characters and observing the segregations which occur in the later generations we analyze the characters of each type and determine when we have a character pair. The researches on this subject by Mendel, Bateson, Davenport, Castle, Punnett, Shull, Hurst, Correns, Tschermak, East, and dozens of other now well known investigators have developed a science of heredity of which we had no conception a few years ago.

We can now study the characters presented by the different varieties of a plant or of different species which can be crossed with it and definitely plan the combination of characters desired in an ideal type and can with considerable confidence estimate the number of plants it will be necessary to grow to get this combination. We now know in general how characters behave in segregation and inheritance, so that we can go about the fixation of a desired type, when one is secured, in an orderly and intelligent way.

The farther the study of characters is carried the more we are coming to realize that the appearance of apparently new types following hybridization is due to recombinations of different units which in their reactions give apparently new characters. As an illustration, in a study of pepper hybrids which I have carried on during the past four years, it has become evident that the form of plant and branching is due to three pairs of characters or allelomorphs, namely; (1) erect or horizontal branches; (2) large or small branches; and (3) many or few branches (fig. 2). In crossing two medium-sized races, one with large, horizontal and few branches, and the other with small, erect, and numerous branches, there results many new combinations of characters, among which appear some with small, horizontal and few branches, which gives a dwarf plant, and others will have a combination of large, erect and numerous branches, which gives a giant plant. These dwarfs on one hand and giants on the other appear as distinct, new creations, though they are very evidently merely the recombinations of already existing unit characters and dwarfness

and giantness are the results of the reaction of the different units combined.

When we remember the large number of distinct characters which are presented by the very numerous varieties of any of our cultivated plants, we arrive at an understanding of the possibilities of improvement which the field of hybridization affords, yet I doubt if many of us have even then an adequate conception of the possibilities. Pos-

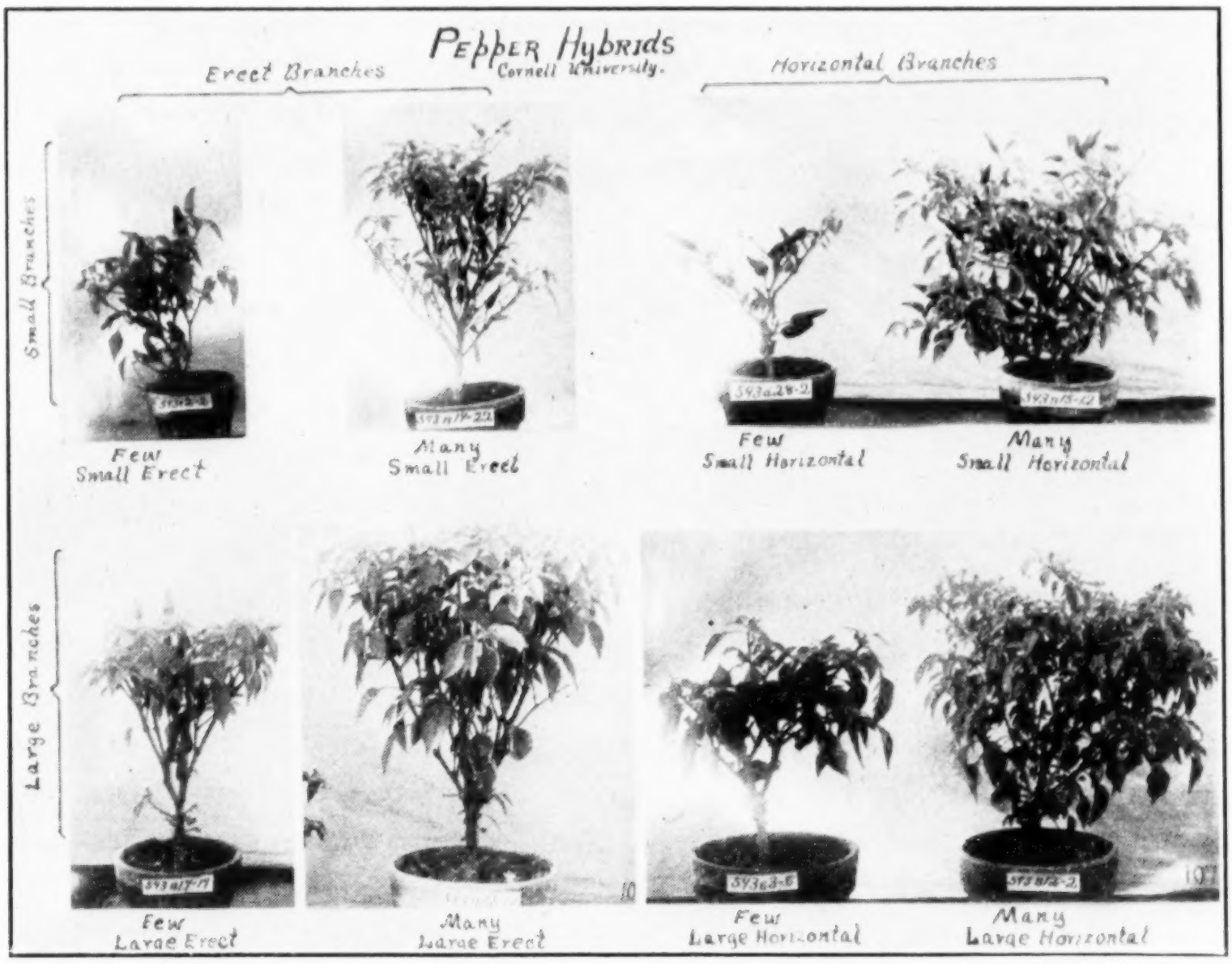


FIG. 2.—HYBRID PEPPERS (RED CHILI ♀ × GOLDEN DAWN ♂)
Segregation in second generation showing the segregation of different types of branching.

sibly I may make this more clear by an illustration from my timothy breeding experiments. While the various characters presented by the different types under observation have not been carefully studied in inheritance, the following characters can be distinguished plainly, and, from observations on accidental hybrids, are known to segregate. The following is a list of 28 such character pairs which it is believed will prove to be allelomorphs:

Timothy Character Pairs

Heads:
- Long or short.
- Thick or thin.
- Dense or lax.
- Greenish or purple when young.
- Gray or tawny when ripe.
- Simple or branched.
- Erect or nodding.
- Continuous or interrupted.
- Apex blunt or pointed.
- Base blunt or attenuated.
- Seeds large or small.

Culms:
- Tall or short.
- Thick or thin.
- Straight or wavy.
- Erect or bent outward.
- Green or purplish.
- Many or few.

Nodes:
- Many or few.
- Green or brown.
- Internodes long or short.

Leaves:
- Long or short.
- Broad or narrow.
- Erect or reversed.
- Rolled or flat.
- Clustered at base or extending to top of culm.

Habit Characters:
- Lodging or nonlodging.
- Rusty or rust resistant.
- Early or late season.

It is possible that some of these characters may be expressions of the same unit, but in several cases they certainly represent several different unit characters. For instance, in length of head, height of culm, number of culms, and season of maturing, several different degrees are certainly present which are fully heritable. Doubtless there are many more than 28 pairs of unit characters which could be distinguished by careful study. If we have two pairs of characters, such as tall or short and early or late, we know that 4 pure homozygous combinations are possible. If three pairs are considered, 8 combinations are possible. Every time we add a different character pair we double the number of different combinations that are possible. Twenty-eight character pairs would thus give us as many possible combinations as 2 raised to the 28th power, or the astonishing number of 268,435,456. It would be possible then to produce this tremendous number of different varieties of timothy if there was any reason to do so, and each variety would be distinguished from any other variety by one distinct character and would reproduce true to seed.

The task of the breeder, then, is to find which among these character combinations gives the superior plant for commercial cultivation. He will soon eliminate certain characters as unimportant and concentrate his attention on those qualities that are essential.

It would be interesting to discuss the factor hypothesis, purity of germ cell, sex limited inheritance, and other important problems connected with inheritance studies, but I have already too severely tested your endurance.

As breeders and genetists we have every reason to congratulate ourselves on the rapid advance of our science and the growing recognition of the importance of the subject in practical agriculture. Colleges throughout the country are extending their courses of study to include genetics. In almost all of the experiment stations studies on genetics and practical breeding are now given fully as much attention as any other subject. With all of this advance, however, only in a few institutions have there been established special professorships or investigatorships in breeding or genetics. If the subject of genetics is to be properly taught or the investigations are to reach the highest standard, it is clear that men should have this as their special and recognized field. The subject should no longer be assigned indiscriminately to the horticulturist, agronomist, animal husbandman, or dairyman. We must establish more professorships of genetics or breeding.

REPORT OF COMMITTEE ON THE HEREDITY OF FEEBLE-MINDEDNESS[a]

DR. A. C. ROGERS, *Chairman.*

Faribault, Minn.

Three institutions for the feeble-minded are employing field workers and investigating the heredity of their inmates. Of these, the institution at Faribault, Minnesota, is the latest addition. The situation there, at the time of writing this report, December 22, 1911, is as follows:

EUGENICS RESEARCH WORK IN MINNESOTA.

The Minnesota legislature, during the session of 1911, made an annual appropriation of $5,000 for each of the two years ending August 1, 1912, and August 1, 1913, for "clinical and scientific work for the hospitals for insane, school for feeble-minded and penal institutions The expenditure of this money is to be made under the direction of the State Board of Control. This board appointed a committee to

[a] Read before meeting of Eugenic Section, Annual Meeting, A. B. A., Dec. 30, 1911.

report upon the best method of procedure. The committee consisted of Henry Wolfer, Warden State Penitentiary; Dr. H. A. Tomlinson, St. Peter State Hospital, and Dr. A. C. Rogers of the School for Feeble-Minded and Colony for Epileptics. The committee unanimously recommended that the initial work be started at the School for Feeble-Minded and Colony for Epileptics and that one field worker should be secured and started immediately. Miss Saidee Devitt was employed upon the recommendation of Dr. Davenport, secretary of the Eugenics section, and placed in the field in October, 1911. Up to the present time she has done the preliminary work on 25 cases, 6 of which have been carefully charted.

So far as the work has proceeded and a knowledge of what is proposed has been disseminated, the reaction of public sentiment has been sympathetic and favorable.

EUGENICS RESEARCH WORK IN NEW JERSEY

The State Home for Women at Vineland, N. J., has for somewhat more than a year employed a single field worker who has investigated about 40 cases from that institution. The results here, while not yet summarized, show practically the same conditions as those to be reported later from the Training School at Vineland.

At the Training School there are still three field workers. The results at the last summary were as follows: More than 11,000 individuals have been investigated and of these somewhat over 1,000 are feeble-minded. There are 22 with histories of criminal acts, while 3,000 or more are normal. There are 286 cases of tuberculosis, 180 cases of alcoholism, 31 epileptics, 114 sexually immoral and 19 histories of syphilis. These results come from the study of the families of about 300 patients. About 65 per cent of the families investigated show the hereditary taint. This material is being worked up for publication in book form. The Mendelian indications will be carefully considered. One family not included in the foregoing has been kept separate because of its peculiar character, the following results being shown:

The chart of this family shows over 1,100 individuals. There have been 41 matings where both parents were feeble-minded. They had 122 feeble-minded children, 25 unknown, 32 died in infancy, 4 died young, 4 miscarriages. Five matings without issue. Total conception 189, or 4.6 per mating. Of these children 15 were alcoholic, 1 tuberculous, 23 sexually immoral, 1 syphilitic, 1 epileptic, 1 criminal, 1 case of violent temper.

There are 8 cases where the father was feeble-minded and the mother normal; the children being 10 normal, 10 feeble-minded, 8 unknown, 6 died in infancy, 1 died young; total 35. Average per mating 4.3.

Twelve cases where the father was normal, the mother feeble-minded. Children 7 normal, 10 feeble-minded, 8 unknown, 6 died in infancy, 1 died young. Two matings without issue. Total number of children 32; average 2.6 per mating.

Both parents normal, 36 cases. Issue, 68 normal children, 13 unknown, 4 died in infancy, 3 died young. Four matings without issue. Total 89 children; average 2.5 per mating.

Sixteen cases where the father is feeble-minded and the mother unknown give 1 normal child and 24 feeble-minded, while 26 cases where the father is undetermined and the mother feeble-minded give 1 normal child and 32 feeble-minded.

There are many interesting things about this family and many items of great social importance. These are being prepared for publication and will soon be issued in book form by Dr. Goddard.

The cases in the Training School will soon have been covered in the somewhat superficial way in which they have so far been gone over, namely, for the main purpose of determining how many individuals were normal mentally and how many were defective. As soon as this work is completed the field workers will be employed to go over the ground again and investigate each family much more in detail to determine what traits that appear in the children were manifest in the parents and grandparents, with the thought of determining, if possible, what are the elements, the unit characters which taken together constitute the complex subject for mental defect, provided this is of itself not a unit character.

A method of making heredity charts which seems preferable to that mentioned in Bulletin No. 2 of the Eugenics Record Office, where rubber stamps were recommended, is in use at the Training School. Gummed labels are used on cross-ruled paper; the paper being ruled in blue, does not reproduce. These labels are prepared by the Dennison Company and there is one for each symbol necessary, viz. a square and a circle for normal, defective, and undetermined. By means of these labels a chart is quickly made and when finished is neat and accurate and ready for reproduction by the photographic method. Anyone interested in this can obtain further details and samples by corresponding with the Training School at Vineland, Department of Research.

EDITORIALS

END RESULTS IN BREEDING

On the whole substantial progress is being made both in the science and in the practice of breeding. Every person who is studying the laws of heredity, or is breeding plants, or animals, or is considering practical plans for the genetic betterment of man has his or her own bent. Each has his own viewpoint as gained by his preparation, study, and experience as to how to proceed in the phase of the subject which he has chosen to pursue. But all of us need occasionally to assume the position of the aviator and from a wide angle of vision let our minds discern which are the really large phases of the subject in which we are interested. The investigator and the breeder alike need to have their minds set upon the high points in the form of the end results. The goal of research is a constant addition to the scientific and usable knowledge of the subject. The goals of the breeder are improved forms, the increased value of which is clearly manifest.

The *American Breeders Magazine* has its peculiar niche to fill. One of its goals is to help hold the genetic workers to the task of rounding up results. The scientist in many cases, needs to be encouraged to be practical. It is better for his work and better for science that he follow one vital thing to a real conclusion than that he skim the surface of a wide range of subjects. In no branch of study is it more necessary to so repeat observations, and to study the subject from every conceivable angle, that true and broad generalizations may be made, than where living protoplasm is concerned. This being true, the investigator should use care and wisdom in choosing problems the solution of which is worth the effort. He should get close to the breeders that he may know their problems. He needs to do his research work in view of the use which may be made of his results; just as the inventor of a machine needs to know the condition under which his invention is to be used. He should be prepared to bring his labors down to the form of practical end results, useful both to science and in the practice of breeding.

In like manner the creative breeder—the person who is trying to produce a species, variety, breed, or strain superior to the available foundation stock—needs to have in mind a definite result. Here again the world will be vastly more enriched by the addition of one real acquisition in the form of a new strain, variety, or breed than by indifferent improvements in each of several species. The need is

not so much that the breeder shall have in mind the exact detail of the newly-formed variety or breed, but rather he should plan that the new form shall better meet a given definite purpose. Those who have passed through the experience of separating out the mutating networks of descent from standard or hybrid foundation stocks, as of wheat, cotton, corn, swine or poultry, and have carried some of these improved varieties or breeds to successful commercial use, know full well that a broadly practical system of selective testing places in the lead those strains whose heredity proves to give the largest value per acre, per animal, per herd or per flock, somewhat regardless of our earlier ideals. We cannot always engraft all of our ideas of form, color, or other desired character on the successful strain. We must carry to commercial use that which under our, at best crude selection, will best serve the farmer or other producer. The writer gained a general view of the problem of plant and animal breeding by employing a few dozen species.

There was need of a Burbank to give the world a zest for the interesting side of breeding and much inspiration has come from him because of the wide range of species he has employed. But the great majority of investigators will accomplish vastly more by confining their efforts to a restricted field or to a problem in which there is need of definite knowledge while the degree of improvement a breeder makes will in the long run not depend on the large number of species he undertakes to improve. And the creative breeder also should generally confine his efforts to one or to a few species. If Burbank, for instance, had spent all his efforts during the last half of his plant breeding activities, in the improvement of let us say potatoes, walnuts, and plums he would probably leave a vastly larger economic result, with a more lasting impulse to breeding than even have been his widely known results with many species.

Creative breeding is a long-time proposition and the public, and especially public boards of directors in charge of such work, should be very sure that lack of results, if such is complained of, is really the fault of the worker, before thinking of changing employees. Sometimes results come only after long efforts, and here especially is good work always cumulative. It is a waste to support a worker through a long period of preliminary training, and of accumulating and testing of foundation of stocks and of analyzing unit characters of foundation material, and then to change to a new worker. What is needed is more workers, and closer division of labor, more attention given to the improvement of individual species.

The possible end results of breeding are of such vast importance that the improvement of the heredity of living things is gradually gaining the status of a recognized public problem of large magnitude. Departments of agriculture and state experiment stations are slowly but surely gaining a strong hold upon the subject of plant breeding. They are slower in undertaking at public expense the genetic improvement of domestic animals, but in such efforts as have been made, no backward steps have been taken. And the vision both of possible practical plans for creative breeding, and of the immense economic results possible to achieve in the end, is gradually widening on the part of these institutions.

One of the least effective parts of our breeding work, with both plants and animals, is the testing of the final product offered to the grower for commercial work. There is not a sufficient number of testing stations determining the comparative values of field, fruit, garden and forest crops, and giving to the growers of each locality accurate information, which variety will under given conditions yield the largest net returns, or best meet any specific requirement. The producers of live stock are in the dark as to the relative values of breeds and families of farm animals. It is safe to say that a billion dollars more crops and live stock products would result annually if, for the past thirty years, we had been spending publicly under scientific direction a million more than has been spent privately, in testing varieties of plants and breeds of animals. The growers are not free of blame, because they are so often indifferent to proof of excellence or inferiority.

But the burden of this work is shifting to the public.

Like many problems, this comes back to a matter of education, and eventually it will pass into the hands of trained men who will create and secure the equipment and will assure the end results. The American Breeders Association's leadership through its committee on pedagogy of genetics, has done some valiant service in bringing attention to the need of trained men and to the methods of developing this as a college and school subject. Prof. Arthur W. Gilbert of Cornell University, the chairman of that committee merits wide coöperation from persons interested in this line of education. There are needed text-books of collegiate grade for those preparing to be teachers, investigators, and creative breeders. Other text-books are needed for agricultural secondary schools and consolidated rural schools. And once that subject is more thoroughly developed may we not hope to have text-books on eugenics? The new literature of

genetics is so far largely in bulletin and report form; new manuals and texts based on recent research are just beginning to appear. The promise is that this vigorous new science of genetics will ere long forge into a most vital place as both an economic and a culture subject in our educational system.

While there is every reason for our public departments of agriculture and agricultural experiment stations to take the lead in placing the science of heredity and the breeding of plants and animals on a strong basis, a large part of the work rests on the shoulders of the farmer. The producer of plants and animals in the aggregate deals with millions of individuals, at any rate with more than the experiment station researcher and breeder. On this account, and also because the grower deals with the individual plants and animals from their birth to maturity, mutating individuals may oftenest be found in commercial fields, gardens, orchards, and forests, and in the herds and flocks of the farmer and stockman.

THE INTRODUCTION OF ANIMALS

The United States Department of Agriculture has developed a world famous organization for the introduction from all countries of plants which promise to be useful under the varied conditions of this country. There are reasons why similar activities have not been so well developed in the introduction of animals. In the first place, there are relatively fewer domesticated breeds of animals in the world, as compared with the number of domesticated varieties of plants. Then, also, there was a vastly greater number of species of plants than of animal which in their native state were especially useful to man. Furthermore, the animals had a will to remain wild, an instinct to resist being restricted to one place, and so the process of domestication had to be an entirely different one. On the other hand many species of plants were at once ready for the garden or field and finding better conditions under care by man throve better than in the fiercer competition in the wild.

The introduction of animals has been left almost wholly to private enterprise. The excellence of the great breeds of cattle, horses, sheep, and swine of the British Islands and the nearby countries of west Europe made possible a profitable business for importers of pedigreed stock. And this field of animal introduction has therefore been fairly well covered. The economic results from the importation of

these improved breeds have been very large. We owe a debt of more than gratitude to the breeders of England, Scotland, the Channel Islands, France, Holland, and other countries. And by purchasing of their most popular strains we have paid large sums on this debt. Some of the fancy prices we have paid have been for animals better in individual appearance than in genetic ability to project their qualities into their progeny. But withal, in case of practically all breeds, our importers have secured a portion of the blood of nearly every long selected or mutating strain of peculiar excellence in the countries named, and while we shall continue to import portions of any newly originated strain of peculiar excellence which may arise in these breeds we already have as good or better foundation stock as have the farmers of the districts in which the respective breeds originated. In fact, in many cases, as in Holstein and Jersey cattle, in Percheron and Clydesdale horses, in Merino and Shropshire sheep, and in Berkshire swine, we have a larger number of the really useful animals of the breed, than has the old country. Our larger numbers, the wonderful scope of our domestic market, both for live stock products and for pedigreed stock, are great advantages which should enable our breeders to keep in front of the breeders of the old country as to intrinsic quality. On the other hand, we lack in the way of live stock keepers who will so nurse to perfection the individual animal and the choicest herd of the breed, as will some of our brethren in England or Scotland, for example.

Our rising agricultural science and education promise to give us the needed technique, the skill in the care of animals, and withal the ambition to create from our present grand foundations vastly better breeds. And why should not our rich live stock land become the great scientific breeding center from which to supply at good prices choice pedigreed stock, as England and her neighbors have so long supplied the best breeding stock to nearly all other countries?

In addition to the continued introduction of the best foreign breeds we already have, there is need of the introduction of other species and breeds. A case illustrating this point is the recent introduction into Texas of the Karakul sheep, to be used in hybridizing with our common breeds in producing first generation hybrids for their fur-like fleeces. Even a more striking case is the introduction by Mr. Borden into Texas of the Brahma breeds of cattle of India which are resistant to Texas fever, and inhospitable to the cattle tick which carries that disease. These cattle are to be produced as pure breds, and to be used in hybridizing with our native cattle. Both the pure

breds and hybrids produce live stock products in the tick-infested South more economically than do the cattle of our other breeds which originally came from the moist, cool climate of west Europe. Mr. Borden found numerous breeds of cattle in India, and in his introduction of thirty head he could hardly have secured the strains of the several breeds which are best adapted to the respective conditions of our varied southern climate and agriculture. He has simply proven that India has breeds of cattle with certain heredity characters which produce rapidly-developing, large beeves in the presence of and quite indifferent to the cattle tick and the fever with which it infects Hereford, Shorthorns, and other European breeds.

Argentina has a breed of horses which had its origin in part in Morgan blood from our own Vermont, which might prove a valuable aid in the efforts now being made at producing a more valuable Vermont Morgan breed. Australia has in her Illawarra cattle a strain of milking Shorthorn blood which Minnesota should at once seek in her efforts at producing a really efficient dual-purpose sub-breed of milking Shorthorn cattle. East Europe is developing breeds of live stock of which we should know in detail. Here we may find breeds useful in their purity, or more likely bearing one or more unit characters needed in creating new breeds for our own use.

Our government needs men highly trained in genetic work and experienced in the breeding of each species and even of each breed; men who know the stocks of the given species or breed throughout the world. They should be familiar with Mendelian characters of the species or breed, its peculiarities, breeding, and the economic value of its strains and families. These men should have advisory and official relations to such breeders as are seriously endeavoring to create new strains and breeds of higher intrinsic value. Such men with an opportunity to aid in the general superintendence of many "breeding circuits" to improve various breeds, as noted in No. 1, Vol. III, of the *Magazine*, would become highly experienced in introducing needed new species and in placing them in their proper niche in our agriculture, to be used either as pedigreed breeds or as the partial basis of new hybrid breeds. By the successful making of new hybrid varieties, our plant breeders ere long will have gotten animal breeders over the theory that no new breeds shall be created. Then there will be no more prejudice to the mixture of the heredity of breeds in making new breeds than to the mixing of paints in making new pictures. On the other hand the indiscriminate mixing of breeds

will be more discredited than now, though the use of first generation hybrids will in many cases be adopted.

Then there is the need of introducing some species now wild. Some of the animals for which we might find use in stocking our extensive mountain pastures for instance, are certain species of small deer. We are in need of fur-bearing animals for our northern unused islands; birds which will thrive in our forests, and fish which might be more prolific in some of our streams and open waters than the species now inhabiting them.

Furthermore our fellow breeders in other countries will not be asleep in genetics and leave the field wholly to us. They will improve present breeds; will utilize first generation hybrids; will continue to form new hybrid breeds, and they, as well as we, will develop refined methods of determining and recording genuine genetic merit. We can find a large amount to do in keeping up with introducing their further improvements. They will bring into domestication more species from the wild and we shall need to secure superior samples of these newly tamed stocks.

The science of stock breeding, following the awakening in plant breeding and in eugenics, is rubbing its eyes; it is yawning, and is showing lively signs of the marvelous awakening of which it is capable. The editor remembers the apathy with which live stock breeders, and even teachers of animal husbandry, only several years back, looked upon the proposition to join the plant breeders in developing the American Breeders Association and its publications. The change in attitude has begun, and the time is ripe for a world survey of the network of animal descent which we need in our business as a nation in the production annually of four billion dollars worth of live stock which should soon be six billions.

NEWS AND NOTES

POSSIBILITIES OF ACCLIMATIZING SOUTH AMERICAN BIRDS AND MAMMALS

Recently I made a journey from Punta Arenas on the Straits of Magellan to the borders of Paraguay, noting with pleased interest the animal life of Patagonia, Argentina, and Uruguay. It seems to me that there are animals and birds in temperate South America that would thrive with us and should be given opportunity to naturalize here.

The South America ostrich lives nearly to the Straits of Magellan or did before men became so abundant. It is yet found far down in the snowbelt. It is common enough in Chubut where the climate is much as we have it in western Colorado. This ostrich is of the easiest breeding. In the fenced pastures it increases rapidly and seems quite hardy and healthy and very tame when not hunted. In Kentucky, southern Missouri, in Maryland, Virginia, and all the south country ostriches should thrive in pastures. They might afford a substitute for our turkeys, now often so difficult to rear. I saw many ostriches in villages, tamed and the pets of the peons, this in northern Argentina, and was told that they came from eggs carried in and hatched in the villages, under blankets. They are said to be fair food if eaten before they become mature, but tough eating when they are old. Their feathers are valuable for making into feather dusters. This hardy, interesting bird should appear in the parks of our wealthy cattle and horse breeders from Washington to Texas, where probably the most congenial climate would be found. In times of deep snow ostriches would no doubt need feeding with us. There would be not the slightest difficulty in introducing ostriches, since their eggs could be sent north,making the voyage in twenty-one days, hatched here with ease and reared more easily than turkey chicks.

There is a little bird that I am told belongs also to the ostrich family, the perdice. It is larger than our quail, perhaps twice as large, with a longer neck. It runs and seldom flies. It is very neat and pretty and is a very favorite game bird. It is often caught by riding it down and snaring it with a noose at the end of a stick. This bird is of great worth and ought to be in our fields. It should be liberated in Texas and Oklahoma and by experiment one could learn how far north it would endure. I saw it in the province of Buenos Aires

most abundant and there no snow falls. I do not know how far south it extends in Argentina.

There is also a much larger bird that flies like a partridge; it is highly esteemed for its flesh and would no doubt be hardy with us in the south; its name has escaped me.

Of animals, I will mention only the "mulita" (little mule), a species of armadillo about 12 inches long in body, with a tail nearly as much longer. The mulita is a harmless little beast, busy hunting for insects and roots. When one is caught it curls up and pretends to be dead. I carried one in my hands many a time when riding across the camps; its body was always delightfully warm and I used it as an animated hand warmer, turning it loose again before coming in to the headquarters of the estancias, since the peons and others eat mulitas and esteem them great delicacies. Mulitas would thrive perhaps from Washington south and could not fail to add interest to the countryside and doubtless perform service as insect destroyers and afford good food as well, if we would let them increase sufficiently for that.

There are many interesting small birds in South America that would, I hope, thrive with us. There is the oven bird that likes to build its mud oven-like nest on gate posts near dwellings. It is interesting and valuable and ought to do well in the south. It is not migratory. It would decrease the insects of the south. It has no bad qualities that I could discover. The cardinal bird, with its bright red head and crest and its cheery song, would thrive throughout our south, and there are many others that could be introduced with profit to us. Conversely, we could send them our robins; they should be at home there if they did not go in the wrong direction when time came for winter migration! There is probably no finer all-around bird than the American robin, in its song, its cheer, its homely, man-loving nature.—JOSEPH E. WING, *Mechanicsburg, Ohio.*

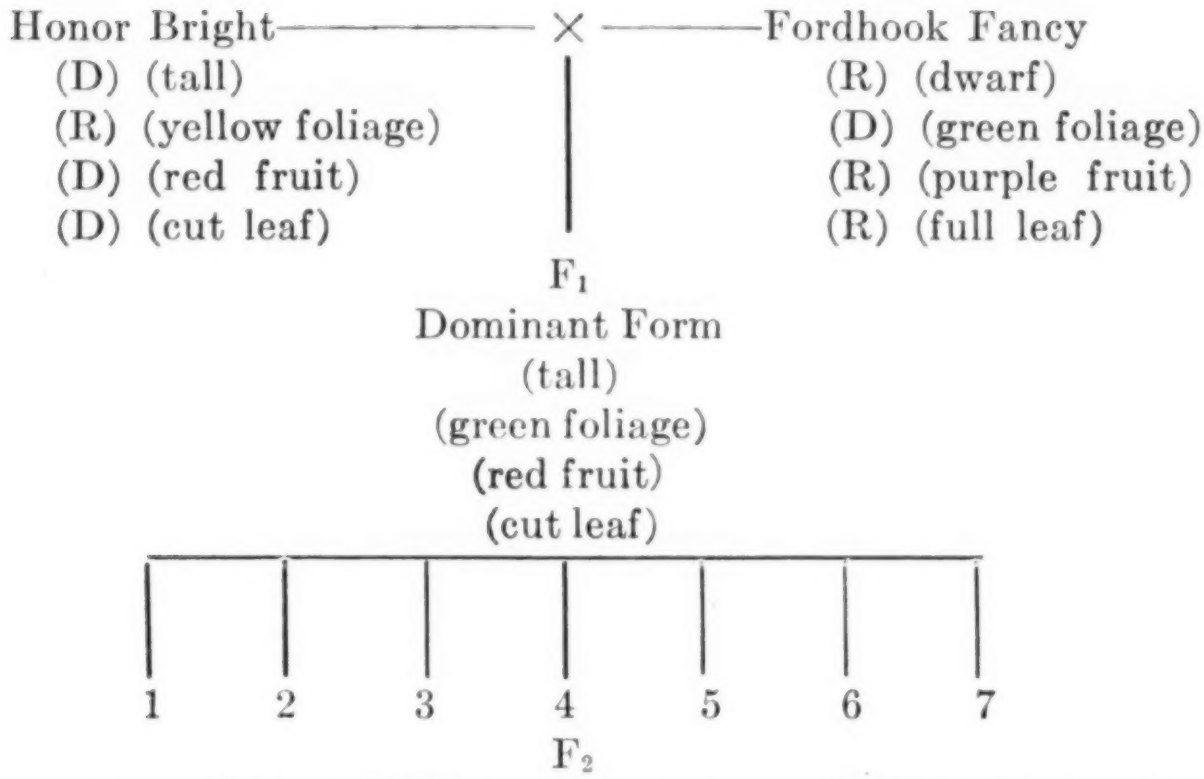
AN EARLY WORK WITH MENDEL'S LAW

During the winter of 1893–94, while working in the Ohio Agricultural Experiment Station greenhouse, I made about thirty crosses of tomatoes of various kinds; among these crosses was one of the Dwarf Champion×Potato Leaf which I afterwards for no apparent reason ran out into the second generation. When in F_2 it showed very plainly segregation of units and gave me a plant of the Dwarf

Potato Leaf. This peculiar stature and form of leaf was new in tomatoes and the plant was sold to W. Atlee Burpee & Company, and introduced in 1899 under the name of Fordhook Fancy. This tomato was strictly homozygote. Although I have raised plants by the thousands I have never seen the least sign of sporting or running back. As far as I know, this was one of the first dwarfs of the tomato to be named aside from the Dwarf Champion; but there have been added quite a number since.

So plainly did this cross show where segregation takes place that I became convinced that there must be some law governing the case. In 1896, while living in Columbus, Ohio, I got hold of a new type of tomato which at the present time would probably be called a "mutant;" this tomato was introduced in 1897 by the Livingston Seed Company, under the name of Honor Bright. This tomato differs from any other kind in a peculiar yellowing of both fruit and foliage. At the present time this form of tomato has become fairly well known, as there are several forms of it, all of which I think I have had the privilege of originating from the first original one. In 1897, I crossed this new "mutant," the Honor Bright, with another new one—the Fordhook Fancy. In pondering over the work that I had done in making the Fordhook Fancy, one day the idea suddenly came to me that the combinations that go to make up the new tomatoes I wanted would be found only in the second generation, and in the first generation I would have something different from what I had used in making the cross. The cross that I had made succeeded, so, by gathering as much seed as I could the following year, I would probably find what I looked for.

The next season I planted enough seed to produce several thousand plants. What might be the total number of kinds that were produced I do not know. The practical plant breeder is interested only in the new and useful kind that may be obtained, and these I had figured out on paper before ever the fruit commenced to ripen, and when "round-up" came in the fall I had six out of a possible seven. Had I not had a fairly clear idea of the law which is now called Mendel's law I do not think I could have obtained these results. These new tomatoes were sold to the Livingston Seed Company and introduced in 1901. Tabulating the work in form of a diagram we have:



1 = Original form of Honor Bright, purple fruit = Livingston's Grandus.
2 = Tall, potato leaf, Honor Bright, purple fruit = Livingston's Princess.
3 = Tall, potato leaf, Honor Bright, red? = Livingston's Multicolor.
4 = Dwarf, potato leaf, Honor Bright, purple = Livingston's Royal Colors.
5 = Dwarf, potato leaf, Honor Bright,red = Livingston's Danay Dwarf.
6 = Dwarf Champions, Honor Bright red = Livingston's Aristobright.
7 = Dwarf Champions, Honor Bright, purple = Green's Neuevo.

Just which of these tomatoes were homozygote I do not know, although we raised No. 7 for several years and it has proven quite true to type. The fact that with help of Mendel's law one can get a new plant that will not vary, I believe to be an important one. The Resplendent tomato, introduced by John Lewis Childs in 1912, is a Dwarf Potato Leaf sort of the Honor Bright type, the fruit being of the Ponderosa-like shape and size. The scientific point of interest in regard to it is that it is a segregation—occurring in the F_2 cross. As far as I can remember, I had no plants of Honor Bright growing on my place for six years before the Resplendent came to light. Tomatoes while not absolutely self-fertilizing, cross-fertilize so seldom that I have never seen a natural cross even when different varieties were grown in the same field. I fail to see why a mutant cannot arise independently a second time, although in this case the fact that there were four plants found that carried the characters of the Resplendent is against it being called a mutant.—E. C. GREEN, *Medina, Ohio.*

RELATION BETWEEN YIELDS OF MILK AND YIELDS OF FAT IN DAIRY CATTLE

The figures given in this article are taken from a master's degree thesis submitted by O. W. Reagin to the Animal Husbandry Department of the Ohio State University.

These coefficients of correlation are concrete expressions of commonly understood general relations between yields of milk and yields of fat in the dairy breeds. They relate in no way to inheritance though they may be of some use in statistical investigation of the inheritance of dairy capacity.

For Guernseys all authenticated yearly records published from 1902 to 1907 were used. Only 250 authenticated yearly Jersey records were obtainable and these cover the period of from 1905 to 1908. The coefficients for Guernseys and Jerseys are comparable. The figures from the two groups of Holsteins can be compared with each other only. Considerable numbers of Holstein yearly records can not be secured and results of 7-day tests were used. Group 1 comprises 1,000 seven-day records made between 1898 and 1902. The per cent of fat was not given in the year books and was computed from the total milk and total butter (80 per cent fat) as recorded. The second Holstein group of records were all made in the year 1908, affording a comparison of the yields of cows of this breed at two times ten years apart.

If in Guernseys, for example, the total fat yields should vary directly with the total milk yield, the coefficient of correlation would then be + 1. It was found to be somewhat less but quite uniform with similar results from Jerseys and Holsteins. The correlation between the pounds of milk and per cent of fat is in all cases a negative one showing that high milk yields are at the expense of richness in fat, or in other words that the yield of fat tends to constancy. The yield of milk and the per cent of fat are much more variable than the total amount of fat. The twelve coefficients worked out are included in the table. The means, coefficients of variability and regression will be furnished to any person desiring them.

Correlation existing between yields of milk and fat and yield of fat and per cent fat in different dairy breeds.

Breed of cattle.	Coefficient of correlation between:			Number of records used.
	Total milk and total fat.	Total milk and per cent fat.	Total fat and per cent fat.	
Guernsey	0.8811 Er. 0.0064	—3093 Er. 0.0258	0.1068 Er. 0.0282	558*
Jersey	0.8725 Er. 0.0101	—3444 Er. 0.0372	0.1319 Er. 0.0414	256*
Holstein I	0.8620 Er. 0.0055	—1851 Er. 0.0206	0.3134 Er. 0.0192	1000†
Holstein II	0.8696 Er. 0.0052	—1516 Er. 0.0209	0.3438 Er. 0.0207	1000†

* Authenticated yearly. † Seven-day records.

The errors in coefficients are not stated as they are in no case large enough to be significant.—F. R. MARSHALL, *Ohio State University, Columbus, Ohio.*

A MILLION YEARS HENCE

It is a common practice among scientists to look back a million years; but it seldom seems to occur to them to look forward that length of time. Perhaps there is more to be gained by such a proceeding than might appear superficially. The general disposition to view the so-called laws of heredity as settled, and the progress of the animal from the primeval slime as beyond question, is apt to cause one, looking forward, to wonder how distant generations of scientists will manage to put in their time.

The truth of the matter is, that while we have discovered a few facts relating to the methods of nature's workings, the trend of recent research work and experimental investigation, have clearly demonstrated the evanescence of hastily concocted formulas. Certain well defined principles emerge to assist the breeder and supplement his practical experience. Depending upon anything further is apt to lead the experimenter off into a maze of unprofitable speculation. Dr. Wilson has shown in one of his later papers how the actual arrangement of chromosomes differ radically from the earlier conception of them. Dr. McClurg brings out the pronounced character of the germ cells of grass hoppers; and Dr. Lillie shows how the different stages of chromosomic development relate to some propensity of the entire organism. We might go on multiplying instances where some

popular biological conception had to be not only modified but radically changed.

There is much disposition to question the mutation theory in its various phases in the light of actual breeding experience as demonstrated by Prof. H. S. Bolley.

Practical breeders everywhere are beginning to find that a great deal of the experimental evidence, in favor of an indefinite multiplication of the earth's useful products, has testified to too much. They see that patient, persistent, personal effort in selection is the thing that counts.

During a million years what convulsions and changes of style will assail the cosmic conception! What discoveries and researches to undermine and disintegrate the biological stronghold! How often, think you, the biologic castle will be stormed and taken by various armies during a million years? How often established and how often contested for by warring faction?—WALTER SONNEBERG.

PUBLICATIONS RECEIVED

A LITERARY NOTE ON MENDEL'S LAW. W. W. Stockberger, U. S. Dept. of Agr. Reprint from American Naturalist, March, 1912. Pp. 151–157.

CONTRIBUTION AL MEJORAMENTO DEL Caballo Para Usos Practicos. Revista De La Liga Agraria, Buenos Aires, 1911. 72 pages. Illustrated. Through courtesy of Wm. R. E. Blonin and Don Carlos Guerrero.

EXPANSION OF RACES. Charles Edward Woodruff, A.M., M.D. 495 pages. Rebman Company publishers, New York.

A review of this book, regarding the value of which the most diverse and opposing opinions exist, will be published in an early number of the *Magazine*.

THE TRAIT BOOK. Eugenics Record Office, Bulletin No. 6. Dr. C. B. Davenport, Cold Spring Harbor, N. Y., February, 1912. 52 pages, 1 text figure, 1 colored frontispiece. Price, 10 cents.

ALFALFA, THE RELATION OF TYPE TO HARDINESS. Philo K. Blinn. Bul. 181, Experiment Station of the Colorado Agricultural College. 16 pages, 14 text figures.

SECOND GENERATION OF THE CROSS BETWEEN VELVET AND LYON BEANS. John Belling, Assistant Botanist. Separate from Report of Florida Agricultural Experiment Station, 1911. 22 pages, 4 text figures.

EIGHTEENTH REPORT. NEGLECTED AND DEPENDENT CHILDREN OF ONTARIO. W. J. Hanna, Provincial Secretary, Toronto, 1911. 124 pages. Illustrated.

DELAINE MERINO REGISTER OF THE NATIONAL DELAINE MERINO SHEEP BREEDERS ASSOCIATION, Washington, Pa. Vol. VIII. 1909. 125 pages.

WOMAN AND LABOR. Olive Schreiner. 299 pages. Frederick A. Stokes Company, publishers, New York. Price $1.25 net.

In her statement of the all too seldom realized fact that "with each generation the entire race passes through the body of its womanhood as through a mold, reappearing with the indelible marks of that mold upon it," Olive Schreiner strikes the keynote of her great book, *Woman and Labor*, which is at once one of the most logical, the most appealing, the most biologically convincing, and the most deeply-foundationed of all the literature which has attempted to deal with the so-called "new woman problem."

Sketching lightly, yet with bold and certain strokes, she draws a picture of the evolution of the human race with woman's part therein, showing that from its very infancy woman has served the race and the common good side by side with man and that in addition to her most important function of incessant child-bearing she has also performed her full share of the labor of supporting the race and of carrying it onward in its appointed path of progress. By many historical citations the author shows that races have held their own in the great battle for existence only so long as their women have labored—have exercised to the full all their qualities of heart, hand, and brain, and that when a race has become so opulent that it was no longer necessary for the women to labor, and when as a result the women became to a greater or a less extent parasitic, that race, producing through its weak and inefficient womanhood correspondingly weak and inefficient men, has gone down before other races whose women were still laboring women—strong in mind and body—virile, efficient, worthy of motherhood. To quote from the book itself: "Only an able and laboring womanhood can permanently produce an able and laboring manhood."

By a comprehensive outline of the economic progress of the ages, Miss Schreiner shows how woman's natural duties have, one by one, been taken from her: how for the spinning-wheels of an earlier generation are now the great steam-driven looms of our factories; for the hoes and grindstones of our earlier agriculture which it fell to the women to tend while the men fought and hunted, are now powerful agricultural implements, man-managed and often steam or electricity driven; how factory-made garments and factory-canned or prepared foods day by day usurp more and more the place of women as useful laborers, "while among the wealthy classes the male dress-

designer with his hundred male-milliners and dress-makers is helping finally to explode the ancient myth that it is woman's exclusive sphere, and a part of her domestic toil, to cut and shape the garments she or her household wear."

Even woman's great labor of child-bearing is being more and more restricted as the race progresses. Since, under modern conditions, our race is no longer decimated by plague, pestilence, famine, or continuous war, incessant child-bearing is no longer demanded of woman. From having been in times past her greatest duty it has come to pass in our present day that "child-bearing and suckling, instead of filling the entire circle of female life from the first appearance of puberty to the end of middle age, becomes an episodal occupation employing from three or four to ten or twenty of the three score-and ten years which are allotted to human life. In such societies the statement (so profoundly true when made with regard to most savage societies, and even largely true with regard to those in the intermediate stages of civilization) that the main and continuous occupation of all women from puberty to age is the bearing and suckling of children, and that this occupation must fully satisfy all her needs for social labor and activity, becomes an antiquated and unmitigated misstatement."

"Looking around then, with the utmost impartiality we can command, on the entire field of woman's ancient and traditional labors, we find that fully three-fourths of it have shrunk away for ever, and that the remaining fourth still tends to shrink."

With these great fundamental truths as her text she makes an impassioned appeal that for the good not of woman alone but of the entire race all fields of labor—scientific, educational, social, economic—be opened to her; that, having travelled the path of human progress thus far side by side with man, it shall not be denied her to go still farther by his side, developing as he develops and, by her own development, reacting upon the race in the production of still stronger generations of men in the years to come.

Taking the splendid ground of racial necessity, she demands that woman be not forced, by the narrowing of her former fields of labor and by the closure to her of all other fields, into a degrading parasitism, and declares the incontestable fact that: "If, at the present day, woman, after her long upward march side by side with man, developing with him through the ages by means of endless exercise of the faculties of mind and body, has now, at last, reached her ultimate limit of growth, and can progress no farther; that, then, here also,

today, the growth of the human spirit is to be stayed; that here, on the spot of woman's arrest, is the standard of the race to be finally planted, to move forward no more, forever: that, if the parasite woman on her couch, loaded with gewgaws, the plaything and amusement of man, be the permanent and final manifestation of female human life on the globe, then that couch is also the deathbed of human evolution."

In the face of these truths, that man or woman must be much more foolish than brave who would dare to stand in the path of any woman who, the traditional fields of woman's labor having failed her, asks permission to exercise her powers in any new field to which her talents or preferences may call her. The author has in this book contributed not only a social document, but unawares perhaps, a strong eugenic one. And whatever personal views one may hold regarding the woman's movement, one cannot get away from the fact that this book presents a number of eugenic questions from an entirely new viewpoint.—HATTIE M. WILSON.

THE HEREDITY OF RICHARD ROE: A DISCUSSION OF THE PRINCIPLES OF EUGENICS. Davis Starr Jordan, President of Leland Stanford, Jr., University. 165 pp. American Unitarian Association, publishers, 1911. Price $1.20 net.

For a panoramic view and a popular and readable statement of the subject of Eugenics we have not yet seen anything which so well covers the ground as this little book. The title would lead one to believe that it is a novel with a problem hidden between its leaves; whereas it is a book on eugenics purely so—Richard Roe being a lay-figure, which helps us to think out the problem in concrete terms.

One fact which recommends *Richard Roe* to the reader, whether he be a general reader or a scientist, is, that the book is not a scientific one; and yet the subject is treated from the modern viewpoint, and the facts of science are presented together with a ripe philosophy of life, and with touches here and there of subtle wit. Its epigrammatic style makes the book entertaining and one reads it with as much tension as a story. Here are a few quotations from the text:

"The purpose of the study of Eugenics is to know the kind of ancestors we should pick for the next generation. . . . ."

"A good stock is the only material out of which history can make a great nation. . . . ."

"In spite of the facts of race suicide, and the number of foolish wives and broken families, motherhood was never so highly esteemed in civilized races as it is today. . . . ."

"The gilded youth and the smart set are not typical of American manhood or womanhood and Richard Roe is not of their kind, for he belongs to a type that lasts. . . . . ."

"In the instant of conception, the gifts of life are granted. . . . . ."

"On the other hand unexpected glories sometimes arise from the happy mating of these common folk whose characters chance to supplement each other. . . . . ."

"Among men there have always been those to whom the art of living was impossible. . . . . ."

No doubt, the largest number of persons who concern themselves with eugenics see it chiefly in its broader light, and its sociological significance, and less in its relation to self and the individual. The author himself seems to have been strongly impressed by the former viewpoint and made it the dominant note in his book, which goes forth from a glance at the subheads of chapters, as instance, a few, taken at random: Race Decline not Collective, Race Decadence, The Poor Whites, Poverty and Pauperism, Paupers or Parasites, Corruption Fund of Public Charity, Foreign Immigration, Future of the Republic, Slavery, The Slums, Luxury, The Higher Foolishness, The Mind of Nations, Breeding of the Superman, All Englishmen of Royal Lineage, The Wholesome World.

Some defects we are quite willing to overlook; thus certain portions of the book bear evidence of either, haste in writing or at any rate lack of painstaking editing; at times the argument does not seem to be fully built out.

THE HORSE, HIS BREEDING, CARE AND USE. David Buffum. 160 pages, 5 inches by 7 inches, 7 text figures. Outing Publishing Company, publishers, New York, 1911. Price, 70 cents.

A treatise on the horse in narrative style, which makes it quite readable. It is evidently written by one who knows his subject well, and the thirteen short chapters abound in useful suggestions as to curing of vices, shying, the education of the colt, treatment of certain cases of sickness, shoeing, etc.

The author very aptly states that "horses vary in character and disposition as much as human beings do and come by their traits in the same way—by inheritance. The disposition of a horse seems to be inherited more from his dam than his sire."

The author is strongly of the opinion that "meanness and viciousness in horses can best be avoided by not breeding it into them. Even if such horses can be subdued and made useful, is it worth while to raise them, if others without these undesirable traits can be raised.

There is a very interesting chapter of about twelve pages on "Our Debt to the Arab" narrating the fascinating story of Godolphins Arabian (in Tunis, Scham and Agba, his keeper).

Horse lovers and horse raisers will do well to add this book to their collection of horse literature.

"TOMORROW." A play in three acts, by Percy MacKaye. 176 pages. Frederick A. Stokes Company, publishers, New York. Price, $1.25 net.

After the reading of this play one cannot fail to be impressed that in this the stage entered the field as a great moral teacher. In "Tomorrow" the author has cleverly and successfully presented one of the big and striking facts of eugenics, precisely as the thinking and seeing observe it enacted daily in real life. There is not a word or an incident which is overdrawn.

The story is simple—love of a woman for a man who had earlier "sowed his wild oats." Her first impulse is to follow him despite all; eventually her training asserts itself and she exercises the rights of her enlightened womanhood and drops the physically poisoned thing for a pure man.

The action of the play is laid in southern California, on the farm of a plant breeder, and the philosophy of selecting, of hybridizing, or of Mendelism and the accomplishments of plant breeding are cleverly and instructively woven into the play.

A characteristic sidelight is given of the attitude of the "practical man," who asks for the meaning of eugenics. A little blind girl is introduced into the play, apparently standing as a living answer to his question. It is probably the first time that the word "plant-breeder" is used in a literary production, and we feel especially grateful to the author for using this word. It is good, it is correct, and the public may as well now learn its meaning and become accustomed to its use. If the author had been a bit more of a scientist, he would have seen that by judiciously drawing upon a few more of the marvelous facts of heredity he could have greatly strengthened the play and added to its general interest.

The central thought of the play is this: That once eugenic truth is taught to women, the race will through them be regenerated, and progress to a new and wonderful human race be assured.

Only six principal characters enter into the play; a select company should be able to make a powerful and appealing presentation of it.

REFERENCES IN CURRENT LITERATURE

PEDIGREED NURSERY STOCK: Circular 18, New York Agricultural Experiment Station. An address given at the meeting of the New York Fruit Growers, Rochester, N. Y., January 5, 1912, by Prof. U. P. Hedrick, Geneva, N. Y.

The author questions the value or rather the commercial practicability of "pedigreed nursery stock." The ground he takes is "that there is nothing to gain even though there be a scintilla of truth in the claims of those who would have nursery stock sold with a pedigree," and "that a fruit grower can spend his time to better advantage than in attempting to breed fruit trees by selection."

In support of this view the author contends that individual seedlings grown from seed of the same plant may vary greatly. On the other hand a bud or a graft is literally a "chip of the old block" and while plants grown from buds may vary because of environment they do not often vary through heredity. "And in case of the occurrence of such a variation, only trial can determine whether or not it is heritable." There is no evidence to show that the total variations, due to "the richer soil, more sunlight, better care, the greater freedom from insects, and diseases, the longer season can be transmitted from parent to offspring. The fruit grower who wants to perpetuate such variations must renew for each generation the conditions which gave him the desirable traits. It is a question of nurture, not nature."

Summing up some of the difficulties standing in the way of pedigreeing fruit trees, the author fears that "opportunitties for dishonest practices would be greatly multiplied. If pedigreed trees become a vogue, tree-growing must become a petty business. Climate and environment would permit nurserymen who are growing pedigreed stock, to propagate only a half dozen varieties of any fruit."

"Fruit trees are not sufficiently well fixed in their characters to make selection from single 'best trees' worth while even should their characters be transmissible."

"The burden of proof is upon those who advocate pedigreed trees, for the present practices of propagating fruit plants are justified by the precedents of centuries."

THE BEST COLOR FOR HORSES IN THE TROPICS. Lieut. Col. Charles E. Woodruff, Med. Corps, U. S. Army, Journal of the U. S. Cavalry Association, September 1911. Pp. 243–263.

Dr. Woodruff has been persistently pursuing the question of the influence of light on living matter and since the publication of his *Expan-*

sion of Races, and *The Effect of Tropical Light on White Man* has in various writings added facts of material values until he has succeeded in bringing together an amount of data which command attention, particularly because of their practical value. The article under consideration is written mainly with the view of eliciting further information on the matter of skin and hair color of horses, mules and cattle for tropical countries and incidentally of all stock much exposed to sunlight.

Dr. Woodruff maintains that "a few belated physicians still profess to believe that nature made a mistake in pigmenting living forms in light countries, but that is no reason why men should be so foolish as to try to acclimatize where God cannot do it." "Acclimatization is now used only by ignoramuses."

He believes that in transferring stock of whatever kind, from one climate and latitude to another, skin and hair coloring is an item that must be considered. If not, the lethal effect of light will effect a selection by killing of the least fit and this is true in tropical countries, climates with intense sunlight, or even large cities where during "hot waves" conditions exist, resembling those in tropical climates.

Best adopted in the tropics are animals with white, gray or sorrel, or mud colored hair and black skin, while for animals in the north temperate zones the best are black skins with either white or light coats.

A NEW SCIENCE AND ITS FINDINGS: Some disconcerting discoveries by Karl Pearson; Albert Jay Nock. The American Magazine, March, 1912. Illustrated with portraits. Pp. 577–583.

An article describing the progress of the study of eugenics in England and making "a plea for the organization of eugenics in this country." The writer displays an amazing lack of information concerning the status of eugenics study and organization in America. We cannot conceive how he can be ignorant of the organization of the American Breeders Association with its three great sections of breeders of plants, breeders of animals, and eugenists. In fact, there is not in all Europe an organization of similar scope. Without discounting the splendid work which our English friends have been and are doing, and the superb body of knowledge of "Rassenkultur" being built up by German scientists, it may in justice be said that America is not lagging behind.

The Eugenics Record Office is a permanent base for the collection and study of eugenic fact. It is, so far as our knowledge goes, the

only eugenics institution having a staff of field workers. There are ten special eugenics committees, composed of men of whom each is an authority in his special line. The *Magazine* presents a great variety of genetic and eugenic subjects in a popular way and the Annual Report contains all the scientific and technical contributions from members. Under the leadership of members of the Association, the formation of eugenic clubs at the important educational centers is being inaugurated.

This in brief is the present status of the organization of eugenics in this country, and we most strenuously take exception to the heedless statement of the writer, who assumes to know what eugenists are doing in this country, but does not.

Mr. Nock suggests: "Let us divert if necessary, a little of the endowment that goes so prodigally into the multiplication of veterinarians, lawyers, dentists, engineers, and doctors, and endow an investigation into the workings of cause and effect upon our supply of men." He is in this only partially right. Funds are needed for research work in general genetics as well as in eugenics. Space is too limited here to explain why this is so.

DIE KARAKUL SCHAFE (The Karakule Breed of Sheep). H. Kraemer Hohenheim, Germany. April 12, 1912, number of *Mitteilungen der Deutschen Landwirtschafts-Gesellschaft.*

In an interesting article, the author reviews the recent contribution to the literature of breeding of karakul sheep by Professor Adametz of Vienna, Austria. This part of the sheep industry has been the object of discussion for many years, but the German with characteristic conservatism and circumspection has never risked going into it on a business scale. Professor Adametz of Vienna, Austria, found that karakuls are extensively bred and valuable furs produced in the Crimea, South Russia and Bosnia. Good results have been achieved at Gross-Engersdorf and at the imperial Thiergarten at Schoenbrunn, Austria. The conclusions which the author draws from all available Russian and Austrian experiments are here condensed very briefly as follows:

That there is not demonstrable any influence of either climate or soil of the steppes of Bokhara and Chiwa, on the quality and amount of "curl" of the skin of the Karakul lamb.

That a deteriorating influence of European climate and feed on pure European bred Karakuls is not observable.

That the characteristic "curl" and "penciling" of the fur is a mendelian character, which had originated probably by mutation.

That this character was probably strengthened by selection, and is capable of still further improvement by the same method.

It seems as if the German farmer was preparing in his systematic and irrepressible way to add a valuable industry to his agriculture. It is chagrining to say the least, that the United States exports annually millions worth of fine furs and skins, but *all as raw material.* Leipzig is the market center of the world's fur trade and our best and costliest skins go there and are reimported after being made valuable by skilled artisans who receive apprenticeship and industrial training in the excellent trades schools of that country. Now the Germans seem to have decided in their own minds that the curl and penciling in the Karakul wool is a unit character and is independent of climate or soil and that those valuable skins can be grown to as great perfection in Mecklenburg as in Bokhara. We would misjudge their proverbial thrift greatly, if they will not exploit that important fact. Here is another side. Does not all this illustrate forcibly the need in this country of a public service organization like the American Breeders Association? And ought not this Association to have at its disposal funds for the study of such and similar questions, which are too expensive and too complex for individuals to undertake, and for study of which it is as a rule difficult to obtain public money?

THE TRANSMITTING POWER AND INFLUENCE OF THE DAM IN DEVELOPING A HIGH CLASS HERD OF PUREBRED DAIRY CATTLE. Charles P. Reed. In the *Michigan Dairy Farmer,* Vol. III, No. 47, February 24, 1912. Pp. 3–6.

WHAT WILL YOUR CHILD INHERIT? Ethel C. Macomber. *Delineator* for April, 1912, with a foreword by Dr. C. B. Davenport.

DISSEMINATION OF PUREBRED GRAIN IN WISCONSIN. *The Farmer,* St. Paul, Minnesota; No. 10, March 9, 1912. Pp. 363–364.

THE RED SUNFLOWER. Prof. T. D. C. Cockerell. *Pop. Science Monthly,* April, 1912. Pp. 373–382.

Journal of Genetics, Cambridge, England.

Contents of February number, 1912:

The history of Primula Obconica, Hance, under Cultivation. Arthur W. Gilbert.

Account of Family showing Minor Brachydactyly. H. Drinkwater.

A Critical Examination of Recent Studies on Color inheritance in Horses. A. H. Sturtevant.

A Further Contribution to the Study of Right and Left-handedness. (Torsion in plants.) R. H. Compton.

ASSOCIATION MATTERS

THE A. B. A. IN FOREIGN COUNTRIES

A most gratifying feature connected with the development of the American Breeders Association is the appreciation of its work by foreign scientists and breeders. The steadily growing world population is making the problem of food supply a formidable one in all countries

The question of enhancing the breeding values of the world's food-supply—plants and animals—has a decidedly international aspect and although bodies of men have organized in nearly all countries into societies serving in each respectively, purposes similar to those of the American Breeders Association in this, it seems, as if the American Breeders Association were universally recognized as the agency most largely concerning itself with that question. At least, that is the only interpretation we can place upon the fact, for instance, that ten per cent of the total membership of the Association are in foreign countries; or the further fact that eighteen per cent of the life members are in foreign countries.

The latest substantial addition to the foreign contingent of our membership comes from Russia. Nine new memberships were sent in by Mr. Basil Benzin of the Department of Agriculture at St. Petersburg, Russia, making the total number of our members in that country fourteen.

Two years or more ago you influenced me to join the American Breeders' Association. The publications have been received regularly and looked over somewhat, although the greater number of articles have been of too technical a nature to be of special interest to me. But in the preparation of a paper which I recently read before the meeting of the Western Michigan Holstein-Friesin Association I found a wealth of good material in the magazines. The information which I was enabled to give has been of such interest that the paper has been widely advertised and republished a number of times.—C. P. REED, *Secretary West Michigan Holstein Friesin Association, Howell, Michigan.*

Volume VI of the Annual Reports has been received, and, to say the very least about the material which it contains, I consider my membership fee better spent, or invested rather, than anything I have ever yet invested.—JOHN C. THYSELL, *Dickinson, N. D.*

You may rest assured that I will always be more than willing to subscribe $2.00 a year for the excellent publication that is gotten out for the American Breeders Association under your efficient direction. Their worth is many times this amount to me.—M. M. JARDINE, Professor of Agronomy, Kansas State Agricultural College, *Manhattan, Kas.*